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GREAT BRITAIN & IRELAND

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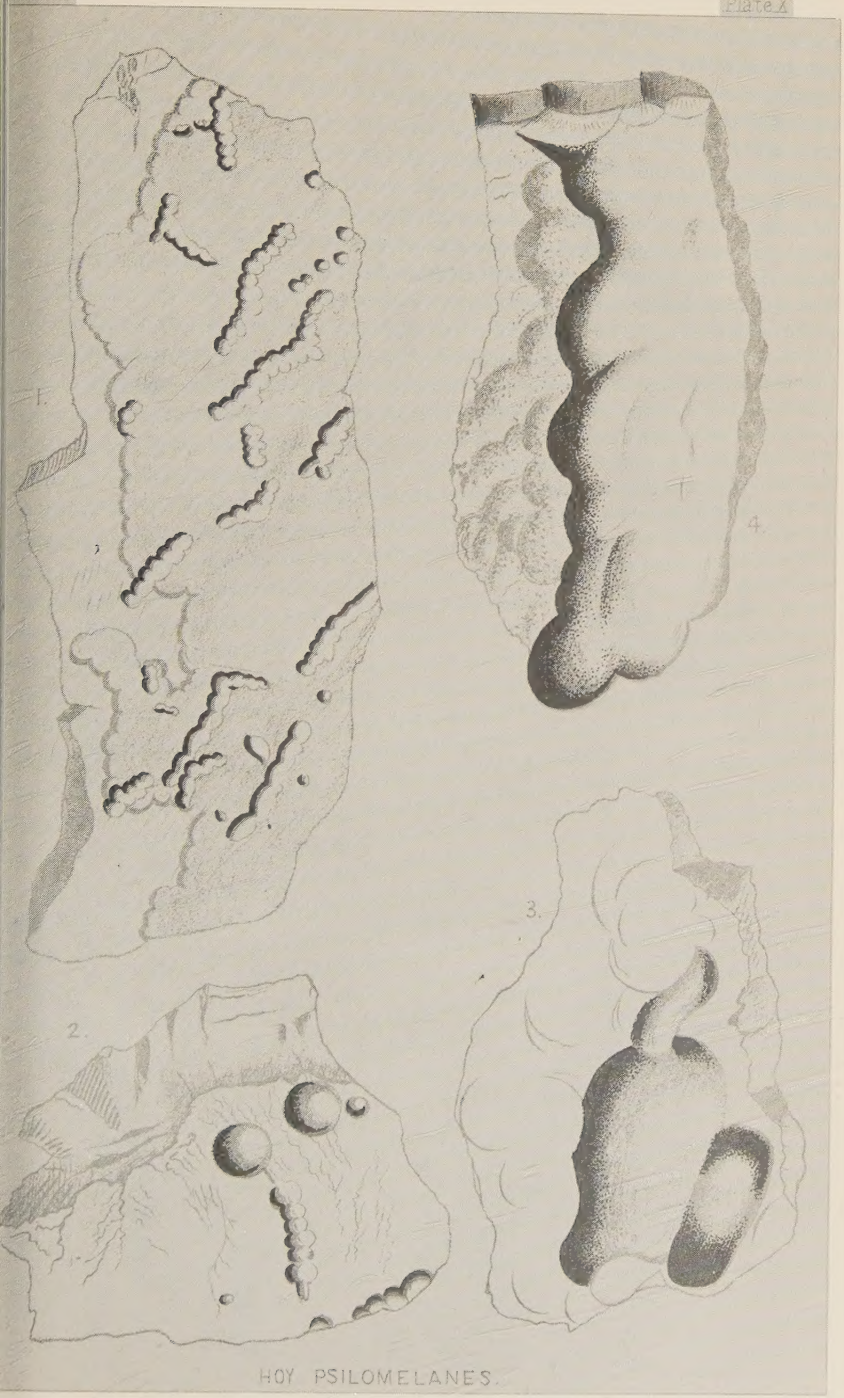

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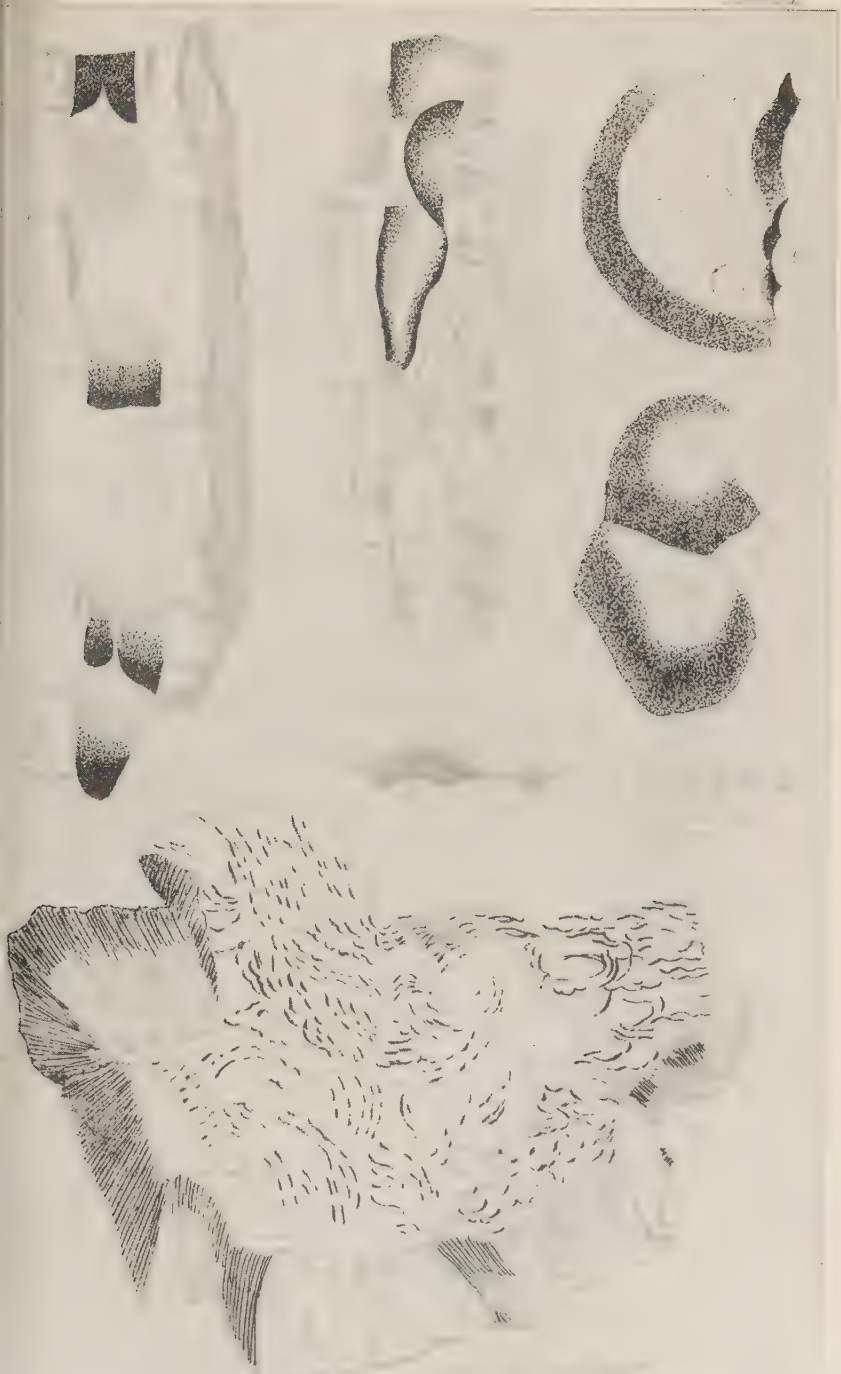

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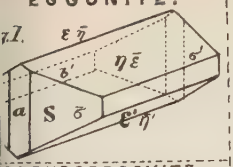

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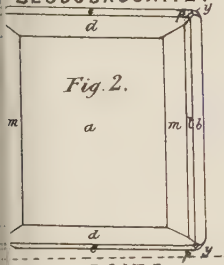

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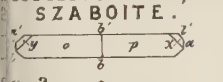

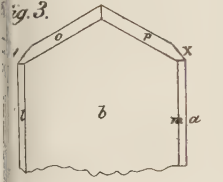

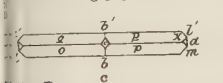

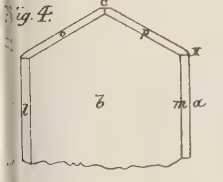

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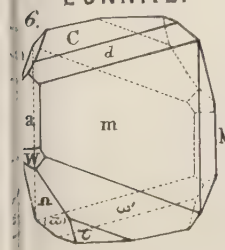

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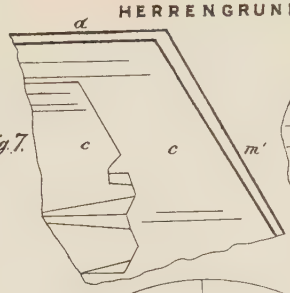

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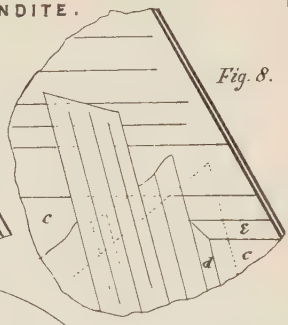

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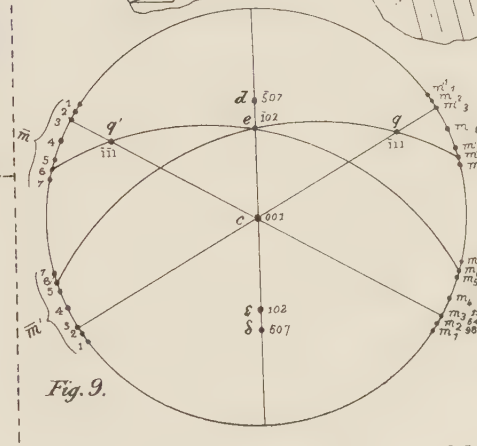

Fig. 9.

Fig. 10.

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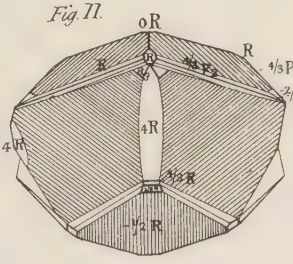

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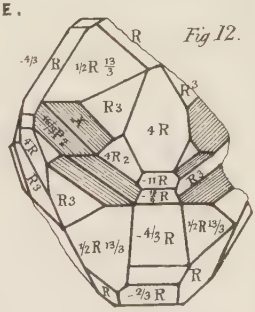

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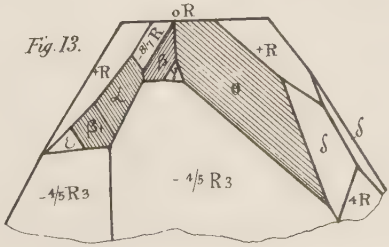

Fig. 13.

LAKE & LAKE, LITH. TRURO.

THE MINERALOGICAL MAGAZINE

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MINERALOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND.

No. 16. MARCH, 1880. Vol. III.

XXI.—*The Geognosy and Mineralogy of Scotland.*

By Professor Heddle.

THE ORKNEY ISLANDS.

Part II.

Pomona or Mainland.

THE localities of geognostic interest in this large island have been referred to in the general description of the islands, and its mineralogy alone now remains to be considered.

It has been remarked above, that the muddy silts which, impregnated with the putrescent pitch of fermenting organisms, form the great mass of the flags of the "Old Red," are exceptionally barren in minerals of interest. The cause of this is not far to seek:—the components of such silts are not themselves those which go to the formation of many mineral bodies;—nor have they been subjected to the metamorphic stimulus which excites to a chemical union of ingredients and elements which lie merely in the contact of granular apposition.

Formed as they are of the triturated and granulated debris of older formations, there are to be found in them the two minerals which may be regarded as the most universally occurring in *all* rock masses,—*baryte* and *pyrite*. These are here found for the most part in veins which fill transverse rents;—and perhaps no better illustration could be given of one of

the essential attributes of the crystallipolar force—its *selective cohesion*—than is here to be seen; namely, the manner in which it can from fa distances draw to sparsely occurring centres, so as to link together in a crystalline structure the minute quantities of these two chemical compounds which occur in the comminuted paste of the older or parent rock.

Small veins of these minerals are not infrequent, but they seldom show anything more than imperfect crystals.

Almost equally frequent are veins of *galena*, these also being trifling in bulk.

The first mineral to which special interest attaches is *avanturine*.

This was found by Mr. G. W. Traill* upon the shore and beneath a cli of, I believe, the lower bed of the fiery-red freestone, noticed as formin the trough which runs through the islands.

This cliff forms the north-west corner of the Bay of Birstane, a branch of Inganess bay. The avanturine was found in small rolled pebbles Occurring only at this spot, they doubtless were either loosened out of th cliff, or were formed by the trituration of the fragments of a band in th cliff,—but Mr. Traill could not find them *in situ*.

These pebbles were none of them of the size of a bean;—in other res pects they are finer than any avanturine I have seen from Scotland They are of that variety of the mineral in which the internal sparkle is du to flakes of mica; indeed, minute regular crystals of it are to be seen. Mr Traill writes—"The mica is in most of the specimens arranged in layers as it would naturally settle in a fluid, and it thus determines the cleavag of the quartz; in other cases there is no such regularity, and the mica i sprinkled about, as in artificial avanturine."

The colour of the quartz being high, the spangles approach somewha to a golden flash, and as the quartz is not at all shivery or loose in struc ture, the pebbles polish fairly well,—some small ornaments made from thei being not markedly inferior to the foreign stone.

Associated with the avanturine, Mr. Traill found interesting specimen of a sandstone of which the appearance is striking, and which discloses i an unmistakable manner that certain of the changes in rocks result fro the action of percolating oxygenated waters.

In this sandstone a uniformly-tinted band overlies one which is profusel sprinkled with elongated spottings of a deep brown-black colour. The spottings, however, are not promiscuously disposed, nor are they in an degree uniform in size. At the line of the junction of the two bands the stone, a multitude of minute dark specks almost eclipse the ordina

* Author of a meritorious monograph of Quartz and Opal.

red tint;—from this line downward these specks diminish in number, but increase in size in an almost equal ratio, and by an almost regular progression. The long diagonal of the ovoid stain is invariably at right angles to the line of demarkation of the bands of the stone. The black markings are ovoidal in two directions at right angles to one another, and circular in cross-section.

The structure, as a whole, conveys the impression that granules of an alterable mineral were sprinkled throughout the sedimenting sand,—at first few in number, but comparatively ample in bulk; and that, as the deposition progressed, the relationship of this mineral to the arenaceous matrix, while it remained much the same in amount, altered in this respect, that the granules become smaller in size but greater in number. The ovoid stains appear to have resulted from oxidation by air-charged water soaking from the atmosphere, which carried a darkening stain downward from the changed mineral,—larger or smaller according to its bulk.

The stained portions have a manganesian or cobaltic tinge; but I have had no specimen whereon I could determine their nature. A drawing is given of the single specimen I possess. (Plate XII).

The Rev. Dr. Clouston in his excellent sketch of the geology and mineralogy of Orkney, drawn up in 1839 for the Statistical Account of Scotland, remarks—"In some places the strata have a bituminous appearance on the surface, or contain little cavities which are filled up with a soft *bitumen* or *petrolium*, occasionaly glance coal?" From the context I am led to believe that one of the localities which Dr. Clouston referred to as affording occasionally a mineral much resembling (for so I read his mark of interrogation) *glance coal*, lies about a mile north of the termination of the granitic-gneiss of Inganess. Here, at least, I found the substance now described.

It occurs in patches, generally imbedded in an inferior blue limestone, but sometimes filling thin cross-rents in the blue-flags. It is of a jet-black colour, and a high obsidian lustre. It is very much rent, so as to spring loose from the matrix in "dressing" the specimens. The fragments thus detached are smaller than peas, and have rhomboidal angles.

It sinks rapidly in water, but I had no fragment large enough to determine its specific gravity on. Its hardness is about 3. *It is soluble in benzole.*

It yielded when burnt at a red heat—

Volatile below 210°	·1	
Gas (highly illuminating)	47·82	
Carbon	51·84	
Ash	·24	H.

The carbon or coke was very light and blebby. Unfortunately I had not sufficiency for an organic analysis. As, however, no known mineral gives anything like the above numbers, there can be little doubt of this being new bituminous mineral; and to it I give the appropriate name of *Cloustonite*, after its discoverer,—a gentleman whose life-long devotion to this and other branches of science, calls for—and has indeed already won for him—an honourable distinction.

Dr. Clouston notes the occurrence in the flagstone quarry at Yesknaby of fine specimens of *dendritic pyrites*; and from Dr. Traill of Woodwick I got specimens of the same mineral, of some size, which bore much resemblance to pseudomorphs after large radiating crystals of arragonite.

Lydian stone and *chert* also occur in association with the limestone of Yesknaby (Clouston.)

Dr. Clouston remarks upon the frequent occurrence of veins of *felspar* in the gneiss; from only two localities was I able to procure it in quantity and quality sufficient for analysis.

The first of these was from the northern extremity of the granite at Inganess. Here it occurs in exfiltrative *nodules* rather than veins, imbedded in the gneiss of the shore, immediately north of, and sometimes in close proximity to the white-trap dyke which cuts through the gneiss.

This *orthoclase* is cream-coloured; its specific gravity is 2·549.

It yielded—

Silica	63·671
Alumina	18·515
Ferric Oxide	·878
Manganous Oxide	trace.
Lime	·731
Magnesia	·307
Potash	13·536
Soda	1·798
Water	·875
	100·311 (H.)

It showed the "corded structure," described by me in the Transactions of the Royal Society of Edinburgh, and therefore probably is *microcline*.

The second of the localities alluded to, is the shore immediately west of the Point of Ness near Stromness.

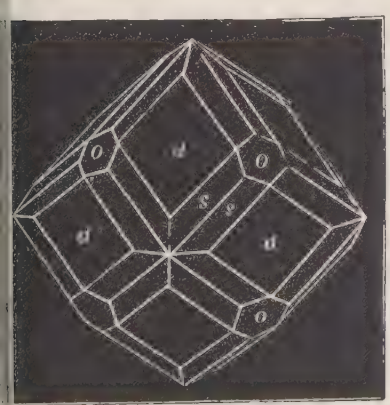
Here the gneiss is cut by many small granitic bands; but it was with difficulty that I obtained enough of the felspar for analysis. Here also it was of a pale flesh or cream colour. It yielded

Silica	60·769
Alumina	18·874
Ferric Oxide	1·318
Lime	3·747
Magnesia	·23
Potash	12·692
Soda	1·95
Water	·862
	100·442 (H.)

This felspar did not show the corded structure. It is altogether singular in composition. While it must be called *orthoclase*, yet it contains a marked deficiency in the amount of silica, and a very large quantity of lime; but as it does not in composition as a whole shade off to any of the other felspars, we cannot but regard it as a variety of orthoclase.

The granite here, but more markedly on its eastern slopes, contains *Haughtonite* (H) in very small flakes; its quartz is milky or even somewhat fatty in lustre; it does not, to the lens at least, show any oligoclase. Lithologically it differs from all neighbouring granites: it differs markedly from any in Shetland; even where most syenitic it bears no resemblance to that of Ben Loyal, and is in no way like either the Ord or the Abriachan rocks; it has, however, some resemblance to some granites of intermediate character, which occur in Aberdeen and Banff.

It passes by almost insensible gradation into gneiss.



Jameson found *garnets* in those parts of the rock which passed to mica-slate. These garnets are very small, but the form figured can be made out.

Clouston registers *rock-crystal*. He also notes the occurrence in it of small veins of *galena*; and I have myself found in the gneiss at the Point of Ness small veins of Traill's *stromnite*.

In one of the letters quoted in the preface of Low's "Tour through Orkney" there occurs the sentence:—"I beg to know what the white

stuff was I sent. It is found *in vein* through the rocks of the Mainland. There is much probability that this was the first observation of th stromnite.

Dr. Traill gives as the composition of this mineral.

Carbonate of Strontia	68·6
Carbonate of Lime	2·6
Sulphate of Baryta	27·5
Ferric Oxide	·1
	98·8

The locality at which Dr. Traill found the mineral was a vein which c the flags, with about a N.N.W. and S.S.E. strike, about 50 yards we ward of the Point of Ness. A breakwater now covers the spot, but dead low-water of spring tides, specimens may still be got from th southern end of this vein.

Here the writer has obtained it, showing minute elongated acicu crystals,—the general mass having in its fracture a laminated appearan This, taken along with the fact that weak acid dissolves out strontia carbonate, leaving sometimes a powder, sometimes a foliaceous loose m of crystals, tends to the conclusion that this is a mere mixture of *stro tianite* with baryte. Some specimens I also find to consist almost sole of strontianite.

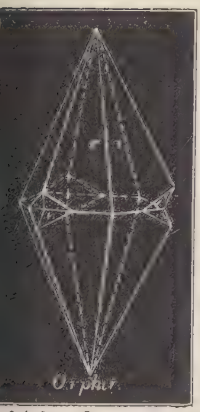
Some minute veins of this substance may be found in the flags westwa of this; and Clouston states that it also occurs in an old lead-mine, abo a mile still further west.

This mine, which was worked for some time, contains cubes of *galen Blende* (H.) also occurs here in double veins of about half-an-inch i thickness, and there are traces of *calamine* and *cerussite*.

Lydian Stone cuts the flags in numerous veins. *Marcasite*, (H) in cock comb forms converted into limonite, coats the rocks occasionally.

The numerous ichthyolytes, which blacken the flags in the vicinity the old mine, have been converted into a jetty-black brittle substanc which was pronounced to be coal by Dr. Fleming; as this substanc though of no constant composition, invariably contains a considerab quantity of phosphate of lime, such an appellation is altogether unsuitabl

A point of very considerable interest connected with this locality is th fact noted above of both the granitic rock and the recent flags being alik cut by veins not only of galena but also of stromnite;—this almos induces the conclusion that the rents had been filled from above.



The shore cliffs which bound the north side of Scalpa Flow are rarely cut by veins of *calcite* (H); from one of these in the parish of Orphir, about half a mile west of Walkmill Bay, the writer obtained twin crystals of the form figured, of about three inches in length.

The freestone cliffs on both sides of the head of the Bay of Scalpa contains veins of lamellar *baryte*, and of *pyrite*; a vein of the latter nearly two inches in width also occurs among the rocks facing Enhallow in the west of the parish of Evie.

In this account of the mineralogy of these islands no attempt is made to enumerate the localities in which *galena* occurs, as it is, so far as I know, always trifling in amount.

As bearing on the question of the elevation of the land, it has to be oted that at Houton Head there is a small cave in the face of the rock, he mouth of which is about 90 feet above flood mark, narrow at the ntrance, but widening and becoming higher towards the inner extremity, hich extends to a distance of about 14 feet.

ISLAND OF BURRAY.

In Low's Tour through Orkney there occurs the following.

"Minerals and indications of mines are frequent in it (Burra); at the outh side of the island was shown a sort of mineral, which Mr. Sangster old me produced lead and some small proportion of silver; but it should eem not so much as to encourage the working of it, and indeed it seems be fuller of sulphur than of silver. At the west end of the island are ain indications of copper, and this also so easily procured as encouraged r Lawrance Dundas to send down a set of miners to work it; however proved but a poor ore, and was given over. I saw some of the ore; it as but light, sprinkled over with a green matter like verdigrease. and on me of the pieces fine blue crystals of copper or vitriol. Mr. Sangster owed me some of the finer ore which was heavy and good, as also a ece of the smelted metal, which is very good and well coloured. He ld me that in breaking through a crumbling sort of rock in working it ey found the purest virgin copper in the appearance of leaves and sprigs trees, according as it had wrought itself through the fissures of the one. Where the miners dug it has all the appearance of a large vein, nfined on each side by a pretty thick partition of a sort of fuller's earth hich entirely separates it from the rocks on each side."

Here we have evidence of the occurrence of *native copper*, *malachite*, *azurite* and either *chalcopyrite* or *vitreous copper*.

The description of the vein indicates one very similar to that of Rousay.

In the same work we read of the Cornholm of Copinsha:—"In the southermost point S.S.W. a quarry of a greyslate much worn through and chinks filled up with spar, but curious on account of the many beautiful figures of seaweeds found between the plates. These figures are most elegantly drawn, and represent a vast variety of weeds, few like them are to be found; they are painted of a brassy color, and many of them very clear, even to the smallest fibres."

In Walluce's account of the Orkney Islands there occurs the following description of the fall of a meteoric stone.

"The air and clouds here, by the operation of the sun, do sometimes generate several things; as some years since, some fishermen fishing half a league from land over against Copinsha in a fair day, there fell down from the air a stone about the bigness of a foot-ball, which fell in the middle of the boat and sprung a leake, to the great danger of the lives of the men that were in it, which could be no other than some substance generated in the clouds.

The stone was like condensed or petrified clay, and was a long time in the custody of Captain *Andrew Dick*, at that time Steward of this country; and Captain *Dick*, who is yet alive, told me he gave it to the late Earl of Glencairn."

ISLAND OF GRÆMSAY.

This island shows on its northern shore between the lighthouses, a section similar to that on the north side of Hoy Sound:—a granitic nucleus with gneissic belts in each side,—these being flanked in turn by the schists, dipping on either hand away therefrom.

The only other notice I have to make of it, concerns what I took to be a dense variety of peat. This I found compacted, doubtless merely by the superincumbent pressure, in a washed out trap-dyke or deep cleft in the rock, near the summit level of the island, and towards its west side.

It seemed to me to bear a resemblance both to a dense peat which I had dug from under about 450 feet of superincumbent strata of alternating trap and peat, in the island of Tintholm in Faröe; and also to an artificially-condensed peat which is sold in London.

The analyses of the three are as follows—

	Græmsay	Tintholm	London	
Specific Gravity ..	1·31 ..	1·27 ..	1·2	
Water	6·06 ..	9·44 ..	3·94	
Volatile at 240° ..	6·88 ..	4.16 ..	6·29	
Gas	15·52 ..	49·40 ..	56·05	
Carbon	·62 ..	20·50 ..	28·08	
Ash	70·92 ..	16·50 ..	5·64	(H)

The Græmsay substance therefore evidently consists largely of earth, and would be useless as fuel.

ISLAND OF HOY.

In a book descriptive of the scenery of Orkney* we read—"Opposite, on the southern side, across the Sound, with its swift-rushing tides, rise the dark and precipitous hills of Hoy, which hold, as with some weird attraction, the spectator's eye. Seamed and scarred by the storms of centuries, they have an aspect of wild loveliness and desolate grandeur. The sea smiles in the sunlight, but they never lose their look of dark sublimity. In the great hollow between the heights the shadows condense into a gloom that might be felt. The effects of light and shade are profoundly touching in their almost unearthly beauty. Here and there on the lower grounds, patches of green come out vividly in sudden gleams of light, forming a striking contrast to the overhanging gloom of the weird and withered hills. The low emerald isle of Graemsay, with cattle grazing amid its pleasant pastures, lying along the waters beneath the lowering brows of the giant heights, enhances still more the wonderful effects of contrasted beauty and gloom. Wreaths of misty vapour, wafted from the wide Atlantic, seem ascending and descending the precipitous sides. No sooner has one mist-cloud drawn up its thin skirts to the topmost pinnacle and melted into thinner air, than another descends, and again the white wreaths rise seething and curling out of the gloom below. The entire view, in its fine combination of sea and land scenery, stimulates the fancy and exhilarates the heart. Seated on the Stromness side of the Sound at sunset, nothing can surpass the mingled beauty and sublimity of the spectacle when the weather-worn hills of Haa-öe loom greenly above the waters, while over their dark summits and through the great gorge between streams a silent flood of yellow light, gilding the swift currents as they glimpse out of the dark-purple shadows."

The scenery of a country is ever dependent upon its geology;—this description of towering hills with sides so steep as to throw sombre shadows over the emerald sward of one of the islands whose geognosy and rocks we have been considering, points unmistakably to an overlying series of rocks; while the contrasted appearance presented by these hills with that of the general aspect of the lower lands indicates, at least, an altogether different formation.

This upper rock consists of a series of beds, which attain a thickness of about 1300 feet. Throughout the whole of this thickness they are of the

* "Summers and winters in the Orkneys."—Gorrie.

nature of freestone; in the lower beds micaceous, and with included masses f decomposing shale, flag, or perhaps mica slate; in the upper showing ittle else than feebly agglutinated grains of sand:—indeed, a deficiency f cement is the marked feature of the rock throughout.

Yellow colours with an occasional tendency to red tints prevail.

It was probably their colour and soft or loose structure, as much as neir superior position, which for long led to their being considered to elong to the New Red Sandstone: Jameson, however, was not so far astray s was at first imagined, when he indicated that he did not think that they vere far off from the Coal Measures.

These thick-bedded and coarse-grained rocks are in no part of the island f Hoy conformable with the flags of the Old Red. A fringe of the latter ccurs both in the north-east, and in the eastern and southern shores of the land, and there are several points where the relationship of the one to the ther is disclosed. At one or more localities, moreover, an igneous rock is nterstitialised between them. The occurrence of this igneous rock had een noticed by Wallace and by Jameson;—the latter says, "in many laces I observed a rock of wacken,"—but its position and relation to the ther rocks was first pointed out by George Anderson, and by Dr. Clouston.

Anderson, in the first editions of his "Guide to the Highlands," writes: All the deposits now enumerated are traversed by numerous dykes, eins, and beds of trap-rocks. The base of the "Old Man of Hoy" consts of an irruptive porphyry rock, supporting an isolated crown of ndstone on its top; in the south-east side of the same island, at Walls, mass of amygdaloidal trap extends nearly 600 yards along the coast."

Dr. Clouston writing in 1839 (Statistical account of Scotland) says,— These secondary strata (the slates) may be found at all inclinations, from orizontal to perpendicular, but in general they dip to the west, at an ngle of about 20°. III. *Sandstone.*—To understand the position of nese rocks, it is necessary to trace them to Hoy, where the sandstone rests pon the slates. This sandstone is easily decomposed by the action of the a, and forms numerous caves and fantastic forms along the precipices here it occurs, of which the insulated rock called the Old Man of Hoy ay be given as an instance. This singular rock is formed of the same rata as the precipice from which it is disjoined; and as this is nearly 000 feet perpendicular, it affords a magnificent exhibition of the strata. he top is red sandstone and the base on which it rests amygdaloid. The nly place where I know of trap overflowing the secondary rocks is one hich I discovered about twelve years ago, in the west side of Hoy, where nere is a bed of it fully 100 feet thick, and, I believe, several miles in xtent. Near the same bed, on the sea shore near Rackwick, I also found fine vein of fibrous gypsum."

A nephew of the writer's found this bed high up in an almost inaccessible portion of the precipice of the Kame, immediately above a spot where the unconformability of the yellow beds to the underlying flags is admirably disclosed,—thus proving its extent to be, as stated by Dr Clouston, "several miles."

Lastly, Professor Geikie has, in his classical paper upon the Old Red Sandstone, founded strongly both upon the unconformability of the upper rock, and upon the intervening igneous platform, in insisting upon a separation of the two sets of beds,—a separation which he makes more absolute in his Geological Map of Scotland, by removing these upper beds altogether from an association with the Old Red, and placing them in line with and at the bottom of the Coal Measures.

In so doing, Professor Geikie has retained the Old Red colouration;—but, following in his track, the writer has, for the sake of consistency, adopted in his map of the island Geikie's Coal Measure tint.

These upper beds of sandstone, then, have nothing in common with the flaggy silts upon which they lie. They differ from them in composition, and in included minerals,—they are altogether discordant with them in dip, and a great igneous sheet, indeed, (as Geikie shows,) two sheets, had been poured out over the flags, and had been solidified, before the sand-grains of the upper rock settled to their place. An enormous period of time, indeed, had intervened between the cessation of the deposition of the true "Old Red" and the commencement of the formation of these rocks. Though it is probably the upper beds of the lower formation upon which they rest, still these beds had been solidified, raised above the waters, and denuded to a great extent, ere ever the volcanic fires had poured that massive sheet over their abraded edges; and what period had elapsed before the dry land had again been submerged and the first grains of sand, borne from the waste of an altogether diverse parent-rock had settled upon the bottom of the new oceanic lake, we have no means of judging. The organisms of the past had, for the most part, ceased to exist; another day in the creative progress had dawned, and almost all things had become new.

The want of cement in these upper sandstones has been noticed:—this, their most marked feature, renders them exceedingly friable, prone to disintegration, and readily subject to aerial waste; streams cut their channels here with ease; the ocean waves cut and carve at them at will; and the old glacial mantle has scalped their summits into rounded contour.

A single central bed of about 60 feet in thickness has somewhat greater closeness and compactness of structure; it shews itself in the

three northmost hills; and, from its cleaving by cross-joints into rude parallelograms resembling somewhat the head of a hammer, it has given to the most southerly of these hills the quaint name of The Hammers.*

The general dip of these beds is to the S.S.W.

The amount of waste of this rock along the ocean verge is enormous,—Five of the hill ranges,—the Coolax, (? *Coolacks*) the Black hill, Melfea, the Snuke, and the Bery—have been cleft sheer off; forming precipices which are nearly mural, and from 600 to over 1100 feet of perpendicular height. Nor, indeed, are the rock-shores which intervene between these ranges of so greatly smaller altitude as to prevent the coast as a whole from presenting the appearance of an almost unbroken wall,—a rampart of towering stone of almost unrivalled grandeur. No one of the individual cliffs, however, can compare in lightness and in elegance with those either of Foula or St. Kilda; the heavy beetling mass of the somewhat higher hill-ground in the back, giving to all except perhaps the Bery and the Snuke, somewhat of the aspect of *a bluff*; and much diminishing the apparent altitude.

One of the detached stacks, however, the far seen and further famed "Old Man of Hoy," stands pre-eminent—*facile princeps* of all in Britain.†

From the abruptness of the truncation of the strata of this upper sandstone, and from its altitude, the view to be obtained from its summit is both panoramic and almost overhanging.

Gorrie, whose power of scenic description is far in advance of his geology, says of the view from Hoy Hill—"Now we stand upon the bald crown, and lo! the whole Orcadian Archipelago, with its islands, holms, stacks, and skerries, lies at our feet like the scattered fragments of some parti-coloured toy-map. It would be difficult to match the spectacle in unexpectedness of scenic effect. There is in it something dreamy, aërial, mystical, unreal. We seem to be looking down upon isle and islet, cape and bay, from the car of a balloon, or the balcony of a lofty tower."‡ This

* Two of these hammer heads have become dislodged, and have fallen into a glen;—one of these having been hollowed out into small chambers, probably by idle hands, is now known as the Dwarfie Stone.

† Gorrie says: "This rock is a huge primeval pillar, standing out from the line of cliffs;—heedless alike of calm and storm, the Old Man of the Sea, like a grim and veteran sentinel at his post, keeps silent watch and ward amid the lonely waters."

So far from being a *primeval* pillar, however, it is formed of much the *youngest* rock in the islands; and so far from being heedless of the storm, one of his limbs lately gave way during a storm, and the "grim sentinel" is now on his last leg.

‡ The sunset view from the summit of Hoy Hill has lately been described in the following lines:—

"Stretched like a map the prospect lies
In varied beauty far and wide;
There, Orphir's green acclivities,
There, Pentland with its raging tide.

description is happy, markedly so in the last line:—but this line shows that Mr. Gorrie had never stood upon the pinnacle of steep Suilven, or he would have reserved his last comparison for that lighthouse-like hill.

Dr. Clouston conceives that this upper sandstone is cut by dykes, and instances the cleft of the Green of Gair as having originated in a washed out dyke. This is nearly opposite to the amygdaloid of the Burn of Berridale; and the occurrence of loose agates on the hill-tops is also strongly confirmatory of the supposition.

The flags in the north end of the island dip persistently directly from the primitive rocks of Græmsay, and maintain this dip till they are encased by the huge enveloping masses of The Hammers, Hoy Hill, and The Coolax. Where overlaid, however, by the towering rocks of the Kame, the dip is to the south west; and as, where they are exposed by sea-scalping in the indentation near the Old Man, they are dipping to the east and south east, there must be a fold under the sandstone of Hoy Head.

In the south end of the island there are many folds; along the east shore these and the dips are inconsiderable; but in South Wales the dip is persistently to the west of north. In the peninsula of Brims, which is probably faulted on both sides, the dip is high; the beds are pronouncedly separated from one another, and a rugged and uncouth line of serrated precipices is the result.

Immediately to the westward of this, there is a great fault, which probably runs continuously northward to the eastern foot of the hill of Melsetter. West of this fault the upper sandstones come in, in the detached mass of the Old Head,—a bold promontory of 150 feet in height, which, faulted on both sides, has its basement strata thrown down below the level of the flags. A dyke succeeds to the fault upon the west; fault and dyke together forming the artificial looking boat-harbour of Sandsgeo. To this a large mass of purple-coloured amygdaloid succeeds.

There is again faulting, succeeded by slabby and micaceous beds of the sandstone, which form the coast-line till they are overlaid by the

---

Ben Hope's huge dome of mystic blue
Looms from afar in form sublime,
Ben Loyal and coned Morven too
Eke out the splendours of the line.

The distant Klibrick rears its peak
In azure tints which melt to sky,
And the grim Griams' contours seek
With varied form to charm the eye.

And Rath's grand capes, mid skies of gold,—
Fit setting for that sapphire crest,—
Their splintered pinnacles unfold
To spangle in the blazing west."

towering and steep-sloped mass of the Bery Head; this, with the much lower Dunnet Head on the Caithness coast, forms the jaws of the Pentland Firth.

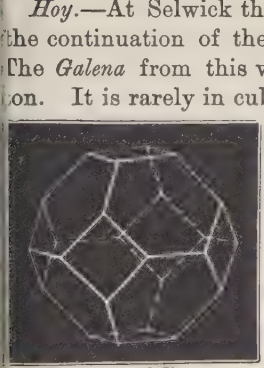
Geikie discovered in Hoy two of the throats of the igneous out-flow; and in South Walls another apparently occurs at the Burn of Simmary; while there are several veins or masses of tufaceous mud, now very serpentinous and decomposed, at the south-west end of the Bay of Melsetter.

A mound, grass clad throughout, which stretches across the mouth of the meadow of the Kame, has much the appearance of a terminal moraine. The hills, both of the lower and of the upper formation, exhibit well marked glacial contours.

We have in this island to consider the minerals of the flag formation, of the sandstone, and of the igneous rocks.

Minerals of the Flags.

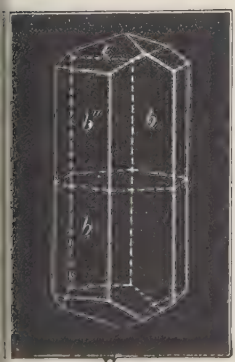
Hoy.—At Selwick there is an old lead mine; it would appear to be the continuation of the vein on the opposite shore of the Mainland. The *Galena* from this vein was said to contain 46 ozs. of silver to the ton. It is rarely in cubo-octahedral crystals.



Rousay and Hoy.

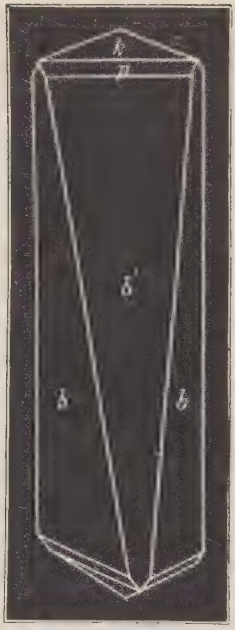
A little north of this, the smooth face of a cliff which faces about due north, is covered with crystals of about an inch in length of *calcite* in the twin-form figured. There are also rarely veins, with crystals of the second form drawn, *b*, *p*, *k*.

A little north of the Manse of Hoy, two veins of *limonite* were worked for some time. These veins run nearly north-west and south-east. The ore is in the botryoidal form, and so dense that the fibrous structure is obscure; it is dark-brown in colour; and is apparently somewhat stained with *reddle*, which occurs in the rock matrix.



Hoy.

Walls.—The flags of this southern part of the island, though they do not contain so many fossils as those at its northern extremity, are in certain localities highly charged with bituminous matters; and those flags which are so charged invariably show upon their surfaces slickenside or friction polishing, of a contorted and grooved nature; as if there had been frequent twistings and rubbings going on among them.



Localities where such dark flags abound, ar the little Bay of Osmondwall, and a little west o the South Ness, in South Wales. At both of thes localities the dip is to the N.N.W. at low angles

A specimen of the Osmondwall flag yielded—

Water	3·11
Gas..	17·61
Carbon	5·936
Ash..	73·044 (H.)

Mr. Low states that out of the "burrows" ther used to be got "beads made of a sort of Lithandra or Parrot Coal, which burn in a candle leavin white ashes, after a very bright white flame."

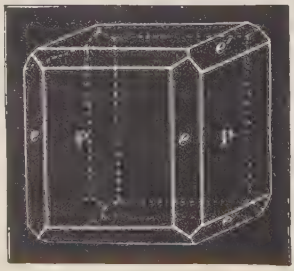
These beads probably were made from the abov flags.

We here see that the term "Parrot Coal" wa in use in 1774.

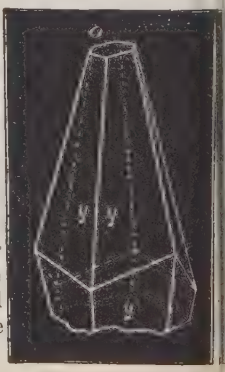
Probably it was the occurrence of these bitum noid flags which led Jameson and others t entertain the hope that coal would be found i this part of the island. There can be litt doubt, however, that the hydro-carbon which impregnates the stone has had its source in animal organisms.

On the east shore of Aith Hope there is a vein which yields specimens of *red hematite*—thi occurs in stalactites which have a hollow core.

At about the centre of the Peninsula o Brims there is a small drained lake, the bed of which is composed of marl; the cracks of the rocks which intervene between this and the sea are filled with calcite. From one of these veins *calcite* in small crystals of the form *m r* that of the figure may occasionally be got.



The flags which are in the immediate vicinity of a "neck" of tufa which has penetrated them at the Burn of Simmary contain vesicles filled with tarry *bitumen*. Other cavities and veins in the vicinity contain *pyrite* in the form *Pe*; crystallised *calcite* also occurs in the form *y o*.



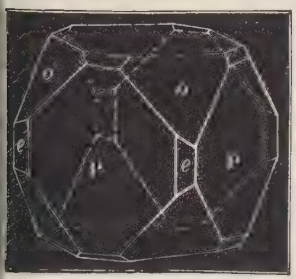
Minerals of the Sandstone.

At this south west extremity of the *cul de sac* called the Meadow of the Kame there are two clefts in the rock, by means of which the cliffs may be scaled. Lining the sandstone of the southern of these, *psilomelane* is rarely to be found.—(H).

Lumps of *reddle* are here also to be met with.

A little west of the highest point of Hoy Head, there is a turret-like projection called Braebrough ; this, which is the most mural point of the whole cliff, is almost isolated ; indeed it is attached to the main line of cliff by merely a narrow neck of lower altitude.

Here Dr. Clouston found a vein of *psilomelane.*



The face of the main cliff upon the right hand of the neck where it faces Braebrough, is covered with crystals of *limonite*, pseudo. after pyrite ; it is in the interesting form drawn.—(H).

About three hundred yards further south, a locality called Lead Geo is reached.

George Low, writing in 1774, says,—"The ores of iron in Hoy are of two kinds, and found in great plenty in two different places. That dug near the Kirk is Hematites. * * * Another kind may be had in vast quantities from Hoy Head, where it runs in many regular veins in the very brink of the sea rocks. This is blacker than the former to appearance, it is much more solid, and weightier, looks as if it had been once in fusion, and had settled in a number of bubbles, which I dare say had not been the case : its first formation is from an infinite number of small particles or drops adhering very firmly together, and growing still more solid as they imbibe more of the iron, till at length it becomes a flint-like mass of the colour above described. Some years ago a company of adventurers from London dug several tons of this last, which they imagined was an ore of Cobalt, but without foundation. They sent several specimens to London, but how it turned out I could never learn. The work, however, was given up. When Mr. Banks was in Orkney on his way from Iceland, he took a step to this mine and smelted a piece of the ore, and assured me of its being iron."

As the ruins of a turf hut are to be seen here, and as the writer found a buried deposit of about four hundred-weight of the ore, near to where there were evident signs of working, there can be no question

that this is the locality alluded to by Low; and, as no galena is now at least to be seen here, the following extract of a letter of Mr. Low may probably explain the name of *Lead* Geo. "Has not your friend* perhaps something mistaken the words of the historian with respect to the black and white lead (*Plumbum album et nigrum*) Buch. History? I have never heard of black lead or "Wad" to be found here, but common lead in many places."

Tne common confusion between *wad* and *graphite*, taken along with the manner in which the hands are soiled in working among the ores which occur at this spot, doubtless led to the adoption of the incorrect name.

The ore described by Low is however not one of iron, but is for the most part *psilomelane*; his "flint-like mass" is a very dense *wad*. There is it is true a small quantity of *limonite*, but not enough to explain the extraordinary statement as to iron having been smelted *upon the spot* apparently,—for so the language used would imply.

Low's description of the ore is most accurate, and, as it will be seen, most suggestive and shrewd.

The veins are situated about 200 feet below the summit of the cliff here called 1130 feet in height.

There are three or four veins still to be with difficulty seen, for the working has, from the precarious footing and the danger of the position, been of a rough and destructive description.

The appearance of the *psilomelane* varies in each of the veins; it occurs in finer masses here than at probably any other known locality.

In its commonest and least interesting appearance it presents itself in mammilated masses with an obscure fibrous structure and a dull lustre. Of this variety the specimens merely as such are the finest. Such masses sheath the sides of the vein and any loose or projecting processes which may occur in its vacuous centre. Though the surfaces of these mammilations are dull, and so soft as to soil the hands, they may when dry be polished by friction; but, when wet, the mineral may by brushing be diffused through water to a large extent.

There is therefore in these specimens a certain approach to *wad*.

Another appearance, though a rare one, is in large flat sheets which possess a mirror-like lustre, and have little trace of fibrous structure.

* *Pennant*. Mr. Anderson, in his introduction to Low's work, very clearly shews the *vampire character* of Pennant's friendship for Low.

In another vein it is of an exceedingly peculiar appearance, sembling a quantity of wires, of the thickness of needles, laid ngitudinally together. The wires can be separated from one another ith perfect ease—they pass transversely from side to side of the vein, hich is about eight inches in width.

Another vein is of the nature of a dense *wad:* it is about two ches in width, is devoid of structure, if it be not of a granular scription, and it breaks with a well-marked conchoidal fracture. his therefore is probably Low's "flint-like mass."

There is one marked fact which is to be observed of all these veins, is that at their sides, the yellow, loose-grained sandstone-rock is ained by the manganese in a manner which forcibly conveys the pression that the ore did not *exude* from the rock into the vein-rent; t was *poured into* the rent, and soaked to a small extent into the rous stone: the limit of the stain is a sharp line of demarkation, it es not shade off with a fainter tinge, to the smallest extent.

I have said that *limonite* is associated with the psilomelane,—it is so sociated in two of the veins only, and its appearance in them is very ssimilar.

In both it is superimposed upon the manganese, but in the one it sumes, or rather attempts to assume a minute stalactitic structure, metimes passing into a pseudo-fibrous or knitted appearance. The ating of limonite however, which does this, has in itself the usual vergent-fibrous growth; the fibrous surface is of a purplish-brown our, and it has a certain amount of the tremulous half-scaly appearance lepidockrokite. But the chief feature of this variety of limonite that its surface, which is dull, has invariably a greenish to an ochery t.

This variety had a specific gravity 3·684, and yielded—

Ferric Oxide	78·787
Ferrous Oxide	3·236
Manganous Oxide	·153
Alumina	·56
Lime	·472
Silica	3·067
Water	14·314
	100·589 (H)

When dissolved in cold hydrochloric acid, a small quantity of light culent silica separates; upon applying heat this went entirely into ution.

The silica therefore is in combination.

The second variety of limonite I found directly coating the sand stone, in one or two specimens; usually it coats the botryoidal psilomelane, and, being a coating of uniform thickness, it assumes the botryoidal form of the under-lying mineral.

The surface of this variety is highly polished—jet black, and splendidly lustrous. Its internal structure is divergent-fibrous but it is tough. The internal colour is purplish-brown, and the lustre satin like to vitreous. Its powder, however, is of a very rich ochre-yellow.

It yielded—

Ferric Oxide	82·135
Manganous Oxide	·343
Lime	·571
Magnesia	·214
Silica	3·315
Water	13·87
	100·468 (H)

Here also the silica was in combination.

The thickness of the coatings of this variety of limonite vary from about the fourth of an inch, to films of extreme thinness—these can always be recognised by their brilliant lustre, and of course by their ochre streak.

Of the *psilomelane* I analysed the massive sub-fibrous variety.

Its specific gravity is 4·607. It yielded—

Manganous Oxide.. ..	66·995=MnO, Mn_2O_3 71·868
Cobalt Oxide..	1·478
Magnesia	·098
Baryta	14·876
Potash	·5
Soda	·003
Oxygen	6·658
Water	6·051
	101·484 (H)

The vein which I have considered to be a dense *wad*, had a blue black colour, and a brown streak.

Its specific gravity is 4·4. It yielded—

Manganous Oxide	64·87	$=MnO,\ Mn_2O_3$ 69·58
Cobalt Oxide	1·995	
Magnesia	·199	
Baryta	14.97	
Potash	·247	
Soda	·259	
Alumina	1·097	
Silica	·898	
Oxygen	5·521	
Water	5·688	
	100·454	(H.)

When this variety is steeped in water and then left to dry, a saline efflorescence exudes from it, which is chiefly a salt of potash; as the specimens had been washed, and also had been buried in wet earth for a century, probably most of the alkalies must have been lost before analysis.

These analyses show that the "London adventurers" were not altogether wrong in conceiving the mineral to be an ore of cobalt.

They also show a most peculiar antagonism to exist between the two closely chemically-allied metals—iron and manganese. Though here occurring together, formed to some extent possibly by similar processes, and superimposed in layers over each other, the iron-ore has almost absolutely repelled the manganese; while no specimen of the psilomelane which I have examined contained a trace of iron. I do not remember ever having examined a mineral which was so absolutely free from the minutest trace of iron.

Cavities in the psilomelane are rarely covered with a velvet-like coating of "*mangan-sammat-erz.*"

Low, in his remarks upon this ore, says that it "looks as if it had been once in fusion, and had settled in a number of bubbles." Though its usual occurrence, in fibrous-mammillations after the manner of the hematites, by no means indicates such a mode of deposition, yet I have already had to allude to indications of its having been *intruded* into the veins from without; and there are certain modes of its occurrence now to be described, which go a very long way indeed to show that some portion of it at least had been in a state of liquidity from heat.

To aid in the description of these, diagrammatic figures of actual specimens have been given; these will be referred to by number.

They group themselves into four varieties.

1. Drops which seem to have been sprinkled over a surface.

2. Drops which seem to have fallen into narrow spaces, and to hav moulded themselves to the bounding walls of those spaces.

3. Pendulous masses, which seem to have run down the surfaces c the sustaining substance.

4. Drops which exhibit shrinkage markings, and which, havin fallen one upon another, have taken an impression or cast of thes shrinkage markings ; but which drops are free from all attachments.

In the case of the first three varieties the so-called drops invariabl lie upon the surface of the glossy limonite : in the case of the la they do not do so, but upon either the mammilated psilomelane, upon other drops.

In the first two cases the drops are perfectly spherical, except wh in contact with their support, or where by juxta position they impin upon each other : they vary in size from the smallest sparrow-hail, bullets which would be about four to the pound.

Their internal structure is obscurely fibrous

The pendulous masses have also an obscurely fibrous structure ; b the drops which came under head No. 4, do not show any structure being like flint when broken.

Fig. 1, plate X, shows a slab of the rock partially coated with thin layer of the glossy limonite.

The rock has a very vitrified appearance, and the absence of th iron compound from *part* of its surface, considered along with th reniform margin of the portion of limonite which does sheathe it, of difficult explanation under any supposition of its having been d posited from water.

Over the smooth and glossy surface of this limonite, and occasionall also over the sandstone itself, there are sprinkled vermiform aggregate of minute spheres of coalescent psilomelane.

The limonite layer is here about the sixteenth of an inch i thickness.

In figure 2 it is about the fourth of an inch, and the surfac though glossy is stalactitically fibrous and rough ; globules larger tha swan-shot are singly or confluently sprinkled over this.

In the specimen figure 3, the glossy limonite (which is sheathin botryoidal psilomelane) has a thickness not much exceeding that of coat of varnish, and upon this two large rounded masses lie ; and

narrow, tortuous, and more recent drop overlies both the limonite and these drops of psilomelane.

Of these three specimens it may be argued that they are not cases of droppings at all, but merely of local segregations of matter which had not deposited itself in a uniform layer over the surface of the limonite; and that it had not done so on account of the smoothness of the latter not only affording but few points or centres for radiant growth, but on account of its oil-like surface acting repellantly to the exercise of ordinary adhesion; and that once that crystalline shoots emanated from the few rough centres which did exist, the succeeding growths were localised at these,—as is so frequently seen in zeolites of a radiating character.

While giving all due weight to this argument, it has to be replied that the manner in which the limonite ordinarily coats the psilomelane, negatives the idea that there had been any repulsion between the two minerals, and that the above argument in no way meets the fact of some of the drops reposing upon the comparatively rough sandstone.

Specimen fig. 4 shows an apparent flow of molten matter over the limonite; it is figured in the position in which it was found in the vein.

So also for figures 1, 2, and 3 of the plate XI. These seem to point to a large drop or drops of a plastic substance which has taken a cast of the narrow crevice which received them. None such were found adherent to the *upper* part of any drusic cavity.

In figure 1 the specimen is looked at from above; figure 2 is the same specimen looked at horizontally, to shew the manner in which the drops have fitted themselves in between the two coats of the psilomelane, which had sheathed the surfaces of the rock-rents.

Figure 3 is a single loose "drop" which has fallen upon others in a narrow vein,—and has a thin adhering layer of *limonite* attached to it upon both of its lateral surfaces.

The specimens which fall to be considered under the 4th head, however, seem to be inexplicable upon any view save that of a succession of molten masses alighting upon one another, after the lapse of definite periods of time,—each period having been of such a duration as sufficed for the solidification of each drop.

In these, a number, sometimes a large number, of *loose* drops are superimposed upon one another, without even so much adhesion as to allow the specimen to be removed from the rock without their falling apart.

There is here no limonite—drop lies upon drop in immediat contact.

The surface of each drop is highly polished; but it is marke throughout with a number of projecting ridges, which bear the mo perfect resemblance to a solidified crust that has been rent an roughened by the contraction of a shrinking and still-liquid centre.

Each drop has taken *the most perfect cast* of that which it has falle upon (or at least of what it lies upon), both as regards the convergin curvitures thereof, and the above-mentioned linear rugosities: and eac drop is on *its upper surface* lined and roughened in a perfectly simila way.

If it be a large drop, it envelopes several of those which are smal and inferior, filling up every interstice between them; and the rugosit upon the upper surface of a large drop are ever larger and mo boldly marked than those upon a small one; as might be expect from the contraction of a more ample mass.

While such a structure as this is in every way accordant wit igneous liquidity, it appears to be altogether inexplicable upon th theory of watery solution, or of deposition of particles which ha been in suspension in a liquid; and the observant Mr. Low wa fully justified in saying that it "looks as if it had been once in fusion, and had settled in a number of bubbles."

Figures 4, 5, 6, and 7 illustrate this fourth variety.

4 and 5 represent two confluent "drops;" in 4 they are seen from above, and in 5 in perspective.

Figure 6 shews the shrinkage crust-cracks; 7 is the magnified ap pearance of one of these, showing an approach to a crystalline structure

I may here state that I possess from another locality a specimen of perfectly amorphous psilomelane, which fills up all the interstices between a number of "stalactites" of hematite—and these stalactites have a markedly-scorified appearance.

But the question of the liquifiability of the mineral may be, to some extent, determined by actual experiment.

In ascertaining the amount of the water in the two minerals it was found that after the application of the heat—nearly a white heat—obtainable from a three-jet Griffin blast furnace, the crushed powder of the psilomelane had agglutinated throughout; while the portion thereof which was in contact with the sides and bottom of the crucible

had fused so far as to be firmly adherent thereto, and to have become glistening in lustre.

The fine powder of the wad again—(which differed from that of the psilomelane in its comportment under heat in this, that it became brown at a red heat, while the colour of the psilomelane was unchanged)—was not only fused to the crucible in its lower portions, under the influence of the white heat, but had collected into distinct drops which were more or less rounded.

It has to be kept in view that, under the concentrated energy obtainable in close cavities, and with the larger amount of alkalies which the *unaltered* mineral would contain, the amount and the ease of the liquifacion must have been more complete.

Upon the surface, about a mile south-west of the Lead Geo, pieces of *limonite* are found lying loose. The length of the fibres of these specimens show that the vein from whence they came must have been of considerable thickness. These specimens have naturally been affected by the weather, and sometimes show alternate bands of *yellow ochre* and *red hematite*,—forming strong contrasts.

Among the cliffs of a rocky gorge at the mouth of the stream or cataract called the Burn of the Sail, *Göthite* occurs in veins, in fine specimens. (H) Minute lustrous crystals of it spangle in the druses of a massive granular hematite; and acicularly-fibrous mammilated masses also occur, the fibres being one-and-a-half inches in length.

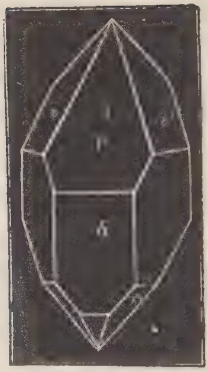
Its colour is chocolate-brown, sometimes banded with ochrey belts; the fibres are very minute.

Its specific gravity is 4·13. It yielded—

Ferric Oxide	84·395
Ferrous Oxide	·054
Manganous Oxide..	·1
Alumina..	1·295
Lime	1·324
Water	10·863
Silica	2·
	100·031 (H)

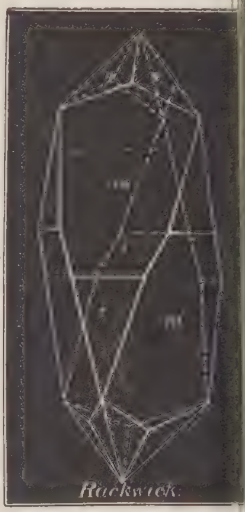
The greater part of the Silica was insoluble in acid.

It was quite similar in appearance, and in the colour of its powder to limonite.



The druses of this Göthite sometimes carry sm
doubly terminated and symmetrically distorted *rc*
crystals, disposed in isolated individuals upon t
surface of the göthite fibres; these form specime
of great beauty.

At Rackwick veins of *satin-spar* were found
Clouston: these veins are narrow, and the fibres a
too coarse for beauty.


Rackwick.

In veins on the north side of this bay, the writer obtained *calcite* in the rare form figured, the crystals are almost an inch in length.

The terminal planes sometimes truncate more deeply so as to cut in upon the faces *c*.

Tremolite is stated to have been found at the Snuke; it probably had been satin-spar which had been mistaken for it.

In the south-west end of the island about half-a-mile north of Turnness, there stands a many-arched stack called the Perforated Rock. The sides of the geos in the neighbourhood yield occasionally reniform *psilomelane*; which indeed occurs in the upper sandstone of the island not unfrequently, though it is generally in thin coatings, and in inferio
specimens.

The sandstone here is somewhat more flaggy and micaceous than
common, and it carries numerous imbedded fragments of *reddle*, and
of a greasy schistose substance which from their round edges and angles
would appear to be the worn and altered fragments of an older rock.

At this locality they are usually of a pale brownish-red colour, often
passing in part of the fragment to a greenish-yellow. They are very
soft, and show occasionally numerous minute scales of mica. They
soil the hands.

A specimen which was chosen as being apparently less altered than
most, was taken for analysis; it was not one of the most *reddle* or
clay-like masses, but rather liker to a shale.

Its specific gravity was 3·43. It yielded—

Silica	62·555
Alumina	17·252
Ferric Oxide	3·458
Ferrous Oxide	2·21
Manganous Oxide	tr.
Lime	·478
Magnesia	1·619
Potash	4·68
Soda	·598
Water	6·72
	99·565

The large quantity of alumina and alkalies in the above do not point to this being a portion of any of the underlying flags—but do point to its being a portion of a highly micacious rock, either a flaggy gneiss, or most probably a mica schist.

It has been mentioned above, that it is probable that the upper sandstone is cut by dykes,—this is rendered probable by the occurrence of frequent specimens of *chalcedony*, which lie loose upon the surface of the hills,—and also, though sparingly, of *agates*. The latter I have even found upon the shores of Hoy.

The specimens of chalcedony are all of one appearance; they are of a pale blue colour, and invariably show casts of curved dolomite or pearl-spar crystals; and from the freshness and sharpness of these pseudomorphic casts, it would seem as if no great length of time had elapsed since the specimens had been dislodged from their matrix.

The agates are pale blue, banded with white in one arrangement, and occasionally containing imbedded chips? of dense dull-red massive jasper. Still more rarely do they show small *amethystine* crystals.

Small rolled masses of a massive yellow *iron-flint* are also found in similar circumstances.

In the cliff face, about a mile north of the precipice of the Bery Head, a long deep crevice or cave runs landward at right angles to the line of the coast. As this is the strike of the trap dykes, and as it has a width of only about three feet, it has possibly been formed by the washing out or disintegration of one of these. It is now studded with numberless *stalactites* of great purity of colour, and considerable lustre. The floor of the recess is a flat sheet of stalagmite, which sometimes is spread over pools of water, and which, breaking with the

weight of the body, allows the leg to plunge into a depth which not improbably may be profound.

Near a wide geo at the western end of the Old Head in Walls, the clefts in the rock are filled with small veins of *Albertite* (H); these veins are not above one-third of an inch in width, and it is singular that it is both the vertical and horizontal rents which are filled with the mineral, which sheathes, and, as it were, cements loose fragments of the rock.

Its specific gravity of this Albertite is 1·076. It yielded—

Volatile below 212°	·54	
Gas	65·72	
Carbon	32·83	
Ash (sand)	·91	(H)

Minerals of the Igneous Rocks.

From among the sands of the shore immediately north of the mouth of the Mill burn near the Manse of Hoy, *iserine* (H) may be collected in some little quantity.

The source of this was somewhat of a puzzle, till Geikie found two masses of tufa a short distance westward; from these the black sand may have been brought down by the stream.

These knolls of trap Geikie regards as two of the throats through which the matter of the platform, which may be said to underlie the whole of the north Hill, from the Coolax and the Kame to Rackwick and Rora Head, was ejected.

Of the black sand here found, very little is *iserine*, or indeed magnetic. The iserine yielded—

Titanic Acid	18·4	
Ferric Oxide	54·979	
Ferrous Oxide	14·422	
Alumina	·6	
Lime	5·6	
Magnesia	·2	
Silica	6·1	
	100·301	(H)

It was in very minute black magnetic grains; these differed considerably in appearance from ordinary granular iserine. When examined with the microscope they were found to consist almost entirely of oval grains with rounded outline. They shine like little

bits of graphite—had few fractures, these were highly lustrous. There was very rarely a doubtful outline of a worn octahedron.

The rocky cliff, immediately above the spot where this iserine is found, forms one of the best flagstone quarries in the island;—and this chiefly on account of the extreme ease with which the flags can be raised. This facility of working is due to the regularly disposed distances of a system of rhomboidal cross-rents.

These resemble, on a large scale, the diamond pavement described near Yesknaby, ; the rents of which, it was stated, had been referred to the action of the weather by Dr. Fleming, but which the writer considered were more probably a part of the structure of the rock itself.

The fact that, in the locality at present under notice, this system of rents is found to continue as far back as the rock has been opened, and where it is perfectly sheathed from, and absolutely unaltered by any atmospheric influence, at once negatives the assumption that atmospheric agents have in any way effected it.

Such rents are usually assigned to shrinkage. There are certain facts, however, which are difficult to reconcile with such an assumed cause. These are, first, that the development of the cracks is very much more pronounced and determinate in some situations than they are in others. Second, that it is difficult to understand how the rents should have taken place *in that inequality of distance*, as regards the individual particles, which is the character of a *rhomboidal* structure; and not in the *equality* which the *hexagonal* structure presents,—(as seen in basaltic columns, starch, furnace hearth-stones, and in an inferior degree in sun-cracks)

The third of these facts is that the rents are not at right angles either to the bedding of the rock,—or vertical to the horizon; as we should expect the rents of such a shrinkage to be, as has to be assigned either to *contact* or *radiant* abstraction of *caloric*, or to the removal of water, either by surface drying, or subjacent heat. The system of joints under consideration. at least such as are part of the *physical structure* of the rock., forms an oblique angle with the bedding. This points directly to the operation of mechanical causes, in all likelihood to pressure or *lateral thrust.*

It would be probably going too far to assign the compression, in the case of the Yesknaby pavement, to the closely adjacent dykes between which that pavement lies; because it may reasonably be held that these dykes merely filled up pre-existing giant-rents in the rock.

It may also be brought forward as a difficulty, that the rents occur where there is no curvature, or crumpling of the strata. But it has to

be maintained that it is just where there are *no* plications of the strata that compression, perchance obliquely directed upon a substance retained in place by great superincumbent weight, would effect such a result; and there is every probability that the system will be found to be best developed where there are numerous faults.

The chief points to be noted as regards the jointing of the Orkney flag-rocks are, that it occurs in an equally well-marked degree when the strata are horizontal, as where they dip;—that the fossils, though frequently rent and having the rents filled with calcite, are not usually much compressed, and seldom distorted; that it cuts thick beds and thin almost alike; and that it occurs in a highly aluminous and frequently bituminous rock,—one in which there is no such approach to uniformity of composition as would warrant the assumption that segregatory process or the force of crystallization had any share either in producing the jointing or even in influencing its direction.

The tufacious rock of the Burn of Berridale has much the appearance of being *in* the sandstone, as it passes for some distance up the rocky sides of the burn. I found nothing in it but masses of *calcite*.

The "neck," if it be one, at the Burn of Simmary contains *asphaltum* and *calcite*.

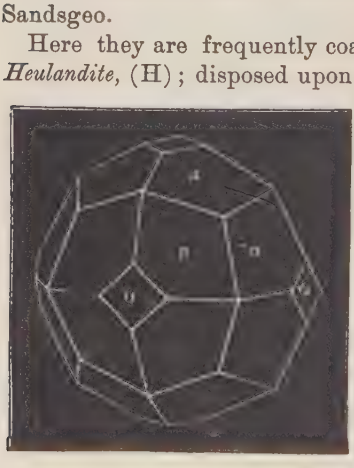
The amygdaloid which occurs at the "Links of Walls" contains innumerable druses.

These at its western extremity are of small size; the "rock-kernels" here consist chiefly of *calcite*, which is coated with light green *celadonite* (H) of a fine colour.

Frequently, however, they are filled with granular *saponite* (H); the specimens are fine; the colour is sap-green.

The druses increase in size towards the east end of the mass, at Sandsgeo.

Here they are frequently coated with a film of minute crystals of *Heulandite*, (H); disposed upon this are crystals of *analcime*—form *P*



(H). The centre of the druse is filled up with *pearl-spar* (H), which carries large imbedded lamellar crystals of white *baryte* (H.)

The druses which yield the finest crystals of analcime are found toward the centre of the mass near the sea-edge; they are of the form drawn.

They are from half-an-inch up to nearly three inches in size, are translucent and colourless, or with a slight

pinkish tint, and they show the face P better than the crystals of any other locality in Scotland.

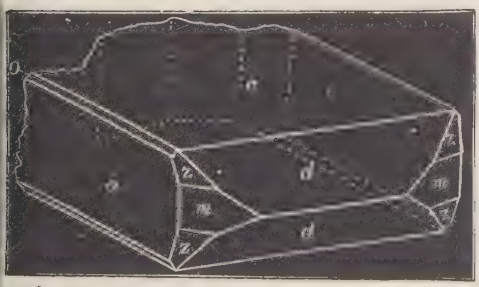
Their specific gravity is 2·244. Their analysis yielded—

Silica	57·624
Alumina	18·724
Ferric Oxide	·193
Ferrous Oxide	·74
Manganous Oxide	tr
Lime	1·888
Magnesia	·459
Potash	1·389
Soda	10·28
Water	8·452
	99·749 (H)

The pearl-spar is occasionally in curved primary crystals. Its specific gravity is 2·78. Its analysis yielded—

Carbonate of Lime	62·4
Carbonate of Magnesia	32·056
Carbonate of Iron	1·74
Carbonate of Manganese	4·276
Insoluble (Quartz)	·16
	100·632 (H)

Chalcedony in thin coatings rarely covers pearl-spar.



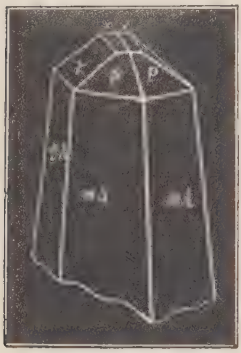
The baryte is rarely in small crystals of the form *c a o d m z*, as drawn.

Imbedded in the pearl-spar I obtained a single specimen of *Babel-quartz*. It was of the fine tint of colour which pertains to the Ben Lawers and Craig Cailleach quartz,—a mixture of brown and amethystine.

Rarely there occur in this amygdaloid druses filled with a mixture of pearl-spar and small foliæ of *rubin-glimmer*; layers of the latter being deposited in bands which accord with the shape of the druse.

The above paragenesis of analcime, pearl-spar, and baryte, I have found to occur in other localities.

ISLAND OF FARAY.



On the west shore of this island some attempt were made to work *galena*. It occurs rarely in cubo-octohedral crystals.

Dr. Fleming found at this spot a vein of *satin spar* about two inches in width; it is of somewhat a grey colour, but is fairly firm in the fibre, and hard.

Arragonite rarely occurred in crystals; the form in the margin is that of the *Unst* crystals.

STACK AND SKERRY.

Though these two rocks are somewhat nearer to Hoy than to the Sutherland coast, geologically they belong to the latter county; for they are formed of a syenite which contains *sphene*, and which is identical in appearance with the syenite of Ben Loyal.

The two would thus appear to be the summits of two hills, much resembling Ben Loyal and Ben Stomino;—a craggy peak, and a flattish dome.

Recent depression of the land. This is considered by many as having, without doubt, taken place. The conclusion is arrived at from the two circumstances of the sea now standing where once there was land,—and from trunks of trees, hazel nuts, and leaves having been dug from beneath sand, at low water-mark, or from their having been thrown up by the waves.

The two may be but one piece of evidence; and that may be shown to be capable of explanation, without calling for any even local movement of the earth's crust,—although such movement is a perfectly recognised, as it has been indeed an oft-repeated fact.

It is probably the case that the fact that the great Bay of Otterswick, in Sanday, was formerly land, is regarded by many as having been more of the nature of an *inrasion of the sea*; and it may be that the very fact of its having been said to have occurred in *one night*, may lead to a proper understanding of what had taken place.

Many trunks of trees are said to have been found beneath the sand all round this bay. The locality in which the writer had the best

opportunities of observing the circumstances and surroundings, was a small bay upon the coast of Rousay, nearly opposite to the little island of Enhallow.

From beneath the sand of this semi-circular bay, tricklings of a logwood-red water may, generally during any unusually low tide, be observed to issue; and the sorely decayed stems of brown-red trees may be seen to project. Upon making the circuit of the bay, it will be observed that these stems slope everywhere, with a very decided dip, inwards to the centre of the bay, or rather to the centre of a circle, of which the shores of the bay would form about a fourth part.

The trees had evidently grown where they fell;—had grown around the circumference of a fresh-water lake,—had fallen upon its banks, or into its waters, to be buried beneath its silts and sands.

Many lakes may at the present time be pointed to in Orkney scarce above the limit of the saline waters;—in the largest of them all indeed, through a very unusual and altogether lunatic arrangement,—fresh and salt maintain a rhythmical possession, for one-half of each day.

There is present evidence, in more than one part of the semi-submerged islands, that through the constant shore nibblings of the sea, the last barrier between it and these littoral lakes, had been one of those boulder-breaches of stones, locally termed "ayres."

Through the open crevices of these ayres the soaking waters commenced their sap; carrying out grain by grain during every tide, the ooze and muddy silts which underlay the peaty and vegetal bottoms of the fresh-water pools;—lowering, through long continued and incessant action, the lake-floors, till the inner prop to the boulder-breach was gone, and, in some time of heavier breaker assault, itself succumbed.

There thus came to be a "little sea" within the land, imperfectly cinctured by a projecting tongue of stones. Rapidly now would the daily sweep and drain of waters suck out its pulpy bed, till the sides "caved in"; its already buried trees would be buried afresh by layer after layer of the sea-shore sand, up to the time when the biting tooth of the ocean made a bay of what had been a lagoon; and, with purpose constant and yet inconstant as its own ebb and flow, to-day would swaddle up what to-morrow it would again lay bare.

XXII—*On Serpentinous Minerals from the Saas Thal and from Scotland.*

By Captain Marshall-Hall and Professor Heddle.

IN a letter to Dr. Heddle, Capt. Marshall Hall writes—"On the next page I give you, in complement of my last letter, the analysis of a serpentine from the Saas Thal. For the specimen I am indebted to M. Henri de Saussure. It will be interesting to compare it on the spot, and study it in its relations to the accompanying rocks and minerals.

Whether the stone is fairly serpentine with so much iron is perhaps to be questioned; I send the analysis as that of a "reputed" serpentine, and I send it to *you* as you have been doing serpentines, ... as it is possible that additional data may be of use to you.

The specimen was a rounded flattish pebble, compactly schistose.

Sp. gravity 2·56;—tough to break.

$Si\ O_2$	40·56
$Al_2\ O_3$	1·40
$Fe\ O$	10·83
$Ca\ O$	0·16
$Mg\ O$	35·20
Loss on ignition (H_2O?)	11·80
	99 95

This analysis was made under the difficulties of no laboratory, no gas, and imperfect appliances generally.

In order to get at the lime, of which I found traces, I took too large a weight of substance, hence the pyrophosphate of magnesia *may* not be quite washed, the precipitate being too bulky. But as this does not appear to me to tend to misguide as to the nature of the rock, I shall not do the analysis overagain. The colour of my solutions indicated *chromium*, but nitrate of silver and acetate of lead did not afford me confirmative evidence. I valuemy domestic peace too highly to take a great lot and examine the H_2S and the NH_4HS precipitates on a large scale. I am rather a nuisance to my family as it is!

With the exception of this, I made a pretty complete qualitative analysis, and *failed* to find Cl, BO_3, SO_3, PHO_5, HFl or CO_2. I did find

SiO_2, FeO, Al_2O_3, CaO and Mg,O, and the emerald and brownish colour-tions which make me suspect chromium. Also a brownish violet bead eemed to indicate mixed nickel and cobalt, in the NH_4HS group. H_yKS gave so feeble a re-action that any little quantity of Fe_2O_3 might ave become oxidised during fusion, solution, and evaporation."*

This is an interesting illustration of the transmutation of what had robably been *enstatite*, into serpentine. It seems to stand nearly inter-iediate in the amount of its change between the two following Scotch pecimens.

On the north-west slope of the Green Hill of Strathedon in Aberdeen-hire, there are to be found specimens very similar to *bronzite*. These may e traced, with a gradual disappearance of their brown colour and their etallic lustre, to a bed of rock which upon a first inspection appears to onsist of an *unaltered hornblende*. Closer inspection, however, discloses a ertain amount of greasy lustre, while the knife shows that there is a eficiency of hardness. The mineral breaks into broad cleavable masses, a dark-green colour, and a structure which is broad-foliated, but is also bscurely-fibrous.

The specific gravity is 3·01.

Analysis :—

Silica	50·921
Alumina	1·893
Ferric Oxide	9·427
Ferrous Oxide	2·085
Manganous Oxide	·307
Lime	8·645
Magnesia	21·582
Potash	·343
Soda	·433
Water	4·536
	100·172 (H.)

In this mineral, in this its less-altered condition, the *apparent* change so slight that the eye alone could not have detected it; and it would t have been selected for analysis, had not the bronzy and more-altered ecimens rendered it desirable to ascertain what were the *first steps* of e alteration.

The other specimens were found much further down the slopes of the me side of the hill. These much more resembled an alteration product of alite or enstatite. They occurred loose, and had palpably suffered much

* The serpentine was difficult to fuse with alkaline carbonates. M.H.

change. They were of a dull olive-green colour passing to fawn: th
had a laminated or flatly-cleavable structure, with cleavages having ang
near to those of augite. They were devoid of lustre, slightly poro
but had plates of talc of extreme tenuity lying between the cleava
planes. Their specific gravity was 2·158; they were brittle and eas
friable.

Analysis:—

Silica	37·412
Ferric Oxide	12·925
Ferrous Oxide	·056
Manganous Oxide	·24
Lime	·179
Magnesia	34·764
Water	13·594
	99·787 (H.)

With traces of alkalies, and 4·545 per cent. of hygroscopic water.

Both of the above contained traces of carbonic acid. Of the first it h
be said that so extensive an amount of peroxidation of the iron could
have been supposed to be compatible with the retention of a bright-g
colour and a brilliant lustre; of the second, that the substance bore
resemblance to the *mass* of serpentine, but did much resemble the *br*
crust which so frequently envelopes serpentine rocks.

Compared with these specimens, it has to be remarked of that exami
by Capt. Marshall-Hall, that the point most to be noted is the fact of
iron remaining in the state of protoxide, while so much water has b
introduced, and silica abstracted;—the small quantity of lime, and
absence of carbonic acid have also to be noted. Its *compactly-schis*
character goes some way in indicating hornblende and not enstatit
the original mineral.

The accumulation of analyses of such substances is the first step
arriving at a knowledge as to the nature of the formation of serpenti

XXIII.—*On the occurrence of Celestine in New Red Marl, near Sidmouth.*

By Spencer George Perceval.

Communicated by F. W. Rudler, F.G.S.

WHILST staying at Sidmouth, in 1877, I discovered the occurrence of Celestine, Sulphate of Strontian, in cavities of Red Marl lined with crystals of Calcite, occurring in masses which had fallen from the cliff on to the shore, under the summit of Peak Hill. It appears in the form of crystals, occasionally one inch in length, which occur singly or in groups, presenting a tabular, prismato-tabular, or prismatic form,—in the latter case resembling the Barytes Crystals of Alston Moor,—and are either simple, or form compound aggregations of considerable size. In colour they are blue, wine-yellow, or of an olive-yellow hue, and as regards form, brilliancy, and transparency, surpass in beauty any examples of this mineral that I have hitherto seen. A series of the choicest specimens collected by me are exhibited in the Museum of Practical Geology, Jermyn Street.

I am informed by Mr. P. O. Hutchinson of Sidmouth, that a small specimen of the mineral was found about 50 years ago, in Salcombe Hill, east of the town, but its occurrence in Peak Hill, west of Sidmouth, appears to have escaped notice.*

* In Greg and Lettsom's Manual of Mineralogy, Celestine is stated as occurring at Sidmouth "on gypsum" and "in flints" Mr. Hutchinson is unacquainted with these modes of its occurrence at Sidmouth, but if the gypsum association is correct, the locality where the mineral is thus found would probably be *east* of Sidmouth. in which direction gypsum does occur. In the British Museum and in that in Jermyn Street, are examples of Celestine occurring on flint from Montmartre, near Paris, but none from Sidmouth.

Reviews and Notices.

On the Phosphates of Copper (A. SCHRAUF, *Zeitsch. f. Kryst. u. Min. P. Groth. IV*, 1.)

THIS paper consists of observations on the minerals Lunnite, Libethenite, Thrombolite, and Veszelyite.

The Lunnite group.—Hermann and after him Rammelsberg have divided this group into three leading types :—

Dihydrite	$Cu_5 P_2 H_4 O_{12}$
Ehlite	$Cu_5 P_2 H_6 O_{13}$
Phosphorochalcite	$Cu_6 P_2 H_6 O_{14}$

All analyses that have been made up to the present fall within the limits thus assigned, but it is nevertheless difficult to discover from these same analyses which variety predominates in any one locality. Besides this, phosphoric acid or water have in many cases been determined by difference, so that the total error of the analysis is accumulated in the determination of one component; a comparison of the various analyses shews great differences in the amounts found, CuO varying between 66·55% and 71·16%, P_2O_5 between 19·63% and 25·30%, and H_2O between 5·97% and 9·06%.

The morphological observations of Haidinger and of Levy shew similar discrepancies; most modern authors, with the exception of Dufrenoy have, however, ignored those of the latter, in spite of their accuracy.

To facilitate the study of these minerals it is best to unite into one group all those that have similar characteristics (monosymmetrical $\propto P = 140°$; Sp. gr.=4·2; Cu=67—71%, H_2O=6—9%) as has been done by Dana; it is, however, preferable to restrict his name of "pseudo-malachite" to the amorphous varieties, and to substitute Lunnite as the name of the entire group, which embraces amorphous, crystalline and crystallised varieties, both aggregated and isolated crystals, which two latter are better considered separately.

The author has examined specimens from Rheinbreitbach, Ehl, Libethen, Nischne-Tagilsk, and Kreuszberg (Bohemia), but his observations also agree well with those of Breithaupt and Hermann on the crystallised varieties from Nischne-Tagilsk and Ullersreuth.

Lunnite is apparently monosymmetrical, but the right and left sides of the crystals are not quite geometrically equal. The system of parameters is therefore: Triclinic $\alpha=89°\ 29'.5, \beta=91°\ 0'.5, \gamma=90°\ 39'.5$, $a : b : c = 2{\cdot}8252 : 1 : 1{\cdot}53395$.

The larger crystals from Rheinbreitbach are polysynthetic, consisting of lamellæ lying parallel to 100. Twin crystals occur formed in accordance with the three following laws:—

(1) Twinplane 100. (2) Twinplane 010. (3) Axis of revolution the axis Y; these are the most frequent laws of twinning in the triclinic system.

Isolated Crystals.—The following is one of the numerous sets of measurements given by the author, the crystal (derived from a specimen from Ehl) being similar to the one represented in the figure (plate XIII, fig. II) except that the left side is not in its normal position, but is twinned, so that $\bar{m}_y$, $\bar{\omega}_y$, occur instead of M, Ω.

	Observed.	Calculated.		Observed.	Calculated.
a m ..	69° 48′	69° 55′	a m_y ..	69° 55′	69° 55′
a $\bar{\omega}_y$ ..	57° 29′	57° 29′	$\bar{m}_y$ $\bar{\omega}_y$ ..	47° 55′	47° 55′
m $\bar{\omega}_y$	106° 59′	106° 47′	a W ..	20° 21′	20° 19′
a D ..	74° 56′	74° 36′	a d ..	75° circa	73° 31′
D d ..	96° 45′	96° 25′	D $\bar{\omega}_y$ ..	83° 57′	83° 34′
d m ..	37° 10′	37° 28′	D $\bar{m}_y$ ..	38° 40′	38° 17′
angle $\bar{\omega}$ a m	127° 8′	126° 49′	angle $\bar{\omega}$ a d	92° 25′	92° 9′
angle $\bar{\omega}$ a $\bar{m}$	52° 11′	52° 11′	angle $\bar{m}$ a m	179° 19′	179° 0′

This last zone angle (179° 19′) is decisive evidence against the assumption of the monosymmetrical system, which would require that $\bar{m}$ a m should equal 180°. As perfectly similar results have been obtained with crystals from Rheinbreitbach by the author, and, according to the descriptions of Breithaupt and Hermann, also with specimens from Nischne-Tagilsk and Ullersreuth, it is impossible, from its morphological characters, to divide this class into two species.

Aggregated Crystals.—Many of the hemispherical masses of Lunnite from Rheinbreitbach consist of radiating, imperfectly developed crystals, whose free ends shew sharp bright planes on the drusy surface of the hemisphere. The author gives numerous goniometric measurements, from which he concludes that these aggregated crystals only differ from the isolated ones in not shewing the protoprism $\propto P = 141°$—a difference by no means sufficient to admit of any division into

separate species, more especially as both agree absolutely in optical characters.

Chemical investigations.—The author gives a large number of analyses both by himself and by other authorities, and finally arrives at the following conclusions:—(1) The amorphous masses, reniform, in concentric layers, which so exactly resemble malachite as to entitle them to the name "pseudomalachite," consist of binary or ternary mixtures in various proportions of Phosphorochalcite ($Cu_6 P_2 H_6 O_{14}$), Ehlite ($Cu_5 P_2 H_6 O_{13}$), and Dihydrite ($Cu_5 P_2 H_4 O_{12}$). They lose perceptibly in weight on heating to 200° C, and have a sp. gr. of 4·2. (2.) The greyish-green fibrous radiating masses from Ehl, with H=2 and sp gr.=4·1, consist of superficially decomposed Dihydrite, and contain silicate of copper; the name Ehlite may be given to this variety. (3) As the proportions of water and copper increase, the crystallising power of phosphate of copper appears to decrease. (4) The crystallised varieties of Lunnite contain the smallest proportion of water, have the highest sp. gr. (=4·4) and consist mainly of Dihydrite, shewing no loss of weight on heating to 210° C. The name Dihydrite should be restricted to this variety.

Libethenite.—The hitherto published measurements of the angles of this mineral by Rose, Mohs, Phillips, etc., shew discrepancies to the amount of about 3°, an amount that cannot be due to errors of observation, and must not be ignored; two explanations alone are possible: (1) The so-called Libethenites from different localities may have different compositions. (2) The morphological structure of Libethenite may be more complicated than is generally supposed. The author now proceeds to shew that this second hypothesis is the correct one; from numerous measurements cited in the original paper, he deduces the following system of parameters:

$$a : b : c = 1{\cdot}4255 : 1 : 1{\cdot}34625. \ \beta = 90° \ 56',$$

thus referring Libethenite to the monoclinic system, whilst the peculiar position of the planes is produced by the revolution of m or M into a twin position on the planes 100 or 001—the commonest laws in the monoclinic system.

It thus appears that the earlier observations were correct, but not sufficiently numerous, and their discrepancies can be well explained by the pseudo-symmetry of the mineral. The outlines of a crystal, which may even seem to be homogeneous, are not always produced by particles (planes) in a normal position, but molecules (planes) in twinned positions may take part in the formation of the superficial layer, and lie in it smoothly without producing an entirely new crystal. Thus, positive

lanes take the place of negative ones, or *vice versa*, and produce pseudo-
ymmetry. These multiple twins differ from ordinary polysynthetic
wins, in the respect that, in the former, the twinned molecules have
ot been able to develope themselves fully, but only form portions of
ne planes; the laws, according to which twinning takes place are,
owever, the same in both cases, but the number of molecules involved,
nd the mode in which they are put together, are different. In order
o distinguish this variety of twinning produced by the molecular
otations of portions of planes, the author calls this phenomenon
Polydymy."

Thrombolite.—Breithaupt and Plattner described this mineral in
838 as a Phosphate of Copper. The author finds, however, that it does
ot contain any phosphoric acid, but has the following composition:

Loss on ignition	(H_2O)	16·56 [Plattner 16·8]	
	Cu O	39·44 [Plattner 39·2]	
	Fe_2O_3	1·05	
	Sb_2O_5	6·65	
	Sb_2O_3	32·52	42·95
Loss ..	(Sb_2O_3?)	3·78	
		100·00	

This composition corresponds tolerably well with the formula
0 Cu O + 3 Sb_2O_3 + 19 H_2O. The proof of the presence of antimony
n thrombolite throws much light upon the remarks of Peters on
ne paragenesis of this mineral; he states that tetrahedrite embedded
n the ore-bearing limestone of Resbanya was changed into amorphous
rombolite. Whilst the formation from tetrahedrite of a phosphate
ould only have been the consequence of a series of secondary
e-actions, simple oxidation would suffice to convert it into Thrombolite,
ne sulphuric acid thus generated combining with the lime of the
natrix.

Veszelyite—a species first established by the author in 1874. The
llowing is a more complete account of the mineral:—Veszelyite
rms thin incrustations upon garnet-rock, and upon the brown
æmatite which is a decomposition product of the latter; these incrus-
ations consist of a granular aggregate of imperfectly developed
rystals; isolated crystals also occur.

System triclinic; $a : b : c = 0·7101 : 1 : 0·9134$; $\alpha = 89°31'$, $\beta = 103°50'$,
$= 89°34'$. The prism (110) predominates combined with the doma

(011). Color and streak bluish-green. Hardness 3·5—4 Sp. Gr. 3·531. The following is the analysis :—

CuO	..	37·34
ZnO	..	25·20
P_2O_5	..	9·01
As_2O_5	..	10·41
H_2O	..	17·05
		99·01

Veszelyite therefore consists of

$$\left\{\begin{array}{r} Zn_3As_2O_8 + 3\,Zn(HO)_2 + 3\,H_2O \\ Cu_3P_2O_8 + 3\,Cu(HO)_2 + 3\,H_2O \end{array}\right\} 3\,Cu(HO)_2 + 3\,H_2O$$

The mineral occurs at Morawicza in the Banat; it was found b Mr. Veszelyi, after whom it has been named.

H. L.

HERRENGRUNDITE (A BREZINA, *Zeit. fur. Kryst. und Min. III*, 4, *p.* 359.) This is a new basic copper sulphate from Herrengrund in Hungary, occurring in "Grauwacke slate" with malachite and calcite. Crystals as in figs. 7 to 10, plate XIII. H=2·5; composition according to Dr. Berwerth.

SO_3	..	24·62
CuO	..	54·16
CaO	..	2·05
H_2O	..	19·61
		100·44

J. H. C.

CALCITE (J. R. MC D'IRBY, *Zeit. f. Kryst. und Min. III*, 5 *and* 6, *p.* 612.) Some remarkable calcite crystals described by J. R. Mc D'Irby of Lynchburg, Virginia, in his work "on the Crystallography of Calcite (*Inaug. diss. d. Gottingen Univ., Bonn*, 1878) are represented in plate XIII, figs. 11 to 13.

J. H. C.

PSEUDOBROOKITE (A KOCH, *Zeit. f. Kryst. und Min., III*, 3, *p.* 306.)— The figure of this mineral given by Koch is reproduced in Pl. XIII, fig. 2. The composition, &c., was given in the *Mineralogical Magazine*, vol. II, p. 248.

J. H. C.

Eggonite (A. Schrauf, *Zeitschrift f. Kryst. und Min. III*, 4, 352, *fig.* 1, *pl. XIII*) was found upon single crystals of silicate of zinc from Altenberg near Aix-la-Chapelle, formed in cavities, coarsely granular, from ferriferous clay mixed with calamine. The name Eggonite (εγγονος grandchild) indicates that it was observed as third in degree in the series of the natural zinc-cadmium combinations.

Triclinic; a : b : c = 1·3360 : 1 : 07989. The axis angle $\beta = 90° 50'$: Planes observed (010) (02$\bar{3}$) (023) (32$\bar{0}$) (320) (100). Twin formation (010), changes the asymmetry into an apparent monosymmetry. H = 4-5; cleavage unknown. Powder shows leaf-like particles. Color light greyish-brown; streak white; imperfect adamantine lustre; translucent to transparent. Before the blowpipe infusible, becoming gray and opaque. With soda carbonate upon charcoal melts to an enamel-like glass, and gives the cadmium incrustation. Zinc incrustation not observed. In HCl and HNO_3, insoluble; or very imperfectly so; with microcosmic salt, gives a *Siliceous* skeleton. Eggonite is therefore essentially a silicate containing cadmium: Morphologically and paragenetically Eggonite stands next to Hopeite.

T. A.

On some Metamorphic Rocks of the High Alps (By Dr Fr. Rolle, *Imp. Geolog. Institute of Vienna, Report of Meeting, May* 31, 1879.)—The crystalline and semi-crystalline rocks of the High Alps of the Grisons, Tessin, and Chiavenna are all sedimentary deposits, more or less metamorphosed. The Casanna schists, consisting of quartz and mica, and lying between garnet-bearing mica-schist and "Verrucano," represent the Carboniferous group. The green schists ("Chlorogrisonite") above the "Verrucano" and the Triassic limestones and dolomites, are variable aggregates of plagioclase, epidote, actinolite, magnetite, specular-iron, and cyanite. They are divisible into *Valrheinite* (plagioclase, epidote, chlorite), *Cucalite* (plagioclase, epidote, and a small proportion of actinolite), *Paradiorite* (plagioclase, actinolite, and some epidote), and *Hypholite* (actinolite in prevalence, plagioclase, and magnetite.) The essential components of the grey schists are quartz, mica, and an opaque substance. They probably consist of detrital gneiss and mica-schist, subsequently metamorphosed. The origin of the green schists may have been connected with the eruption of pyroxenic volcanic ash.

COUNT M.

On some specimens of Nephrite (By Dr. Fr. Berwerth, *Imper. Acad. Sciences, Vienna, Report of Meeting, July* 17, 1879.)—Crystalline

portions of a block of New Zealand Nephrite, weighing 123·32 kilogrammes, proved to be identical with *actinolite* both in crystallographic and chemical constitution. The crystals are separately imbedded in compact Nephrite. The largest of them measure five millimeters in length. Under the microscope they offer the same characters as the crystals of actinolite embedded in the talcose and chloritic schists of the Alps. The chemical composition is the same as that of the actinolite of Arendal, analysed by Rammelsberg. It answers to the formula—Si_{20} Fe_2 Ca_5 Mg_{11} H_6 O_{61}.

The compact portion of the block seemed to be a compound of compressed and intricate fibres, including some few scattered crystals of Actinolite. The chemical formula for the compact mass is Si_{10} Fe_2 Ca_5 Mg_{11} H_8 O_{62}. This is the same as that of several fragments of nephrite found in lacustrine habitations. A variety of nephrite, called "Kawakawa" by the New Zealand natives, has been analysed, and its formula ascertained to be Si_{20}, Fe Ca_5 Mg_{12} H_6 O_{61}.

COUNT M.

THE MELAPHYRE OF HALLSTATT, UPPER AUSTRIA (By F. VON HAUER, *Imper. Geolog. Institute, Vienna, Report of Meeting, July* 31, 1879.)—In the winter of 1878 melaphyre was met with in the Salt-mines of Hallstatt. It is dark-green, compact, of amygdaloid structure, and in a state of advanced decomposition. Its cavities and fissures are filled with pellucid rock-salt and some gypsum. Microscopic examination of thin slices shows it to be composed of small crystals of plagioclase, a chloritic mineral, and a small proportion of magnetite, interspersed with larger crystals of plagioclase, decomposed pyroxene, and a substance showing many grey points. In some cases, yellowish-brown, partially decomposed pyroxene is discernible; and the structure of some decomposed portions proves that olivine was present previous to the decomposition. The whole is impregnated with rock-salt and gypsum. Silica occurs in cavities, either amorphous, or as quartz. The results of chemical analysis are:—Substances (1) soluble in water (chloride of sodium and gypsum) 10·90 per cent; (2) soluble in chlorhydric acid, after treatment with water (sesquioxide of iron, alumina, lime, and magnesia,) 35·55 *p.c.*; (3) insoluble in chlorhydric acid (silica, lime, alumina, and magnesia, 47·10 *p.c.*; water and the alkalies (calculated by the difference) 9·45 *p.c.* A direct determination of the silica gave 44·25 p.c., hygrometric water, 1·26 *p.c.*, loss by ignition, 7·45 *p.c.* Another specimen gave 2·54 *p.c.* of chloride of sodium and traces of gypsum.

The melaphyre appears to constitute a *Massif* amidst the saliferous rock, striking S.E.—N.W.: near its south-eastern termination it takes the form of a breccia, with fragments enclosed in the salt-rock. Westward it is separated from the overlaying, feebly saliferous rock, by a seam of gypsum. These melaphyres may be of Triassic age.

COUNT M.

On the Diffusion of Cerium, Lanthanum, and Didymium.—(A communication from Prof. A. Cossa, of Turin.—*Bull. de la Soc. Min. de France*, 4, 1879.) In 1846, Wöhler observed that apatites from Arendal, in Norway, contained 2 to 3 per cent. of a crystallised phosphate of cerium, irregularly distributed in a state of mechanical mixture, and which he called Cryptolite. It may be separated from the apatite by dilute nitric acid, in which it is insoluble. In 1851, Weber found the oxides of cerium and yttrium in apatite from Snarum. In 1872, Church found phosphate of cerium in apatite from Jumilla. The author has analysed fourteen specimens from the most diverse localities, and finds that they all contain phosphates of cerium, lanthanum, and didymium, united molecularly to phosphate of lime, and that cryptolite therefore does not really exist. His observations were made with a small spectroscope, and verified in the case of the apatites from Snarum, Bamle, and Canada, by chemical analysis, the details of which are given. The three apatites just mentioned furnished solutions which exhibited clearly the system of brilliant striæ characteristic of the electric spectrum of lanthanum.

The presence of cerium, didymium, and lanthanum has been found in many apatites which do not exhibit an absorption spectrum, and also in three specimens of limestone, viz.: saccharoid marble from Carrara, a shelly limestone from the province of Avellino, and lastly in a stalactitic deposit in an earthenware pipe leading from a Roman aqueduct near Cividale, in Frioul. These last experiments were made with the greatest precautions on about two kilos. of limestone each time; each kilo. gave about 2 cgrms. of oxalates of cerium, lanthanum, and didymium.

Experiments were made on the Scheelite of Traversella, which contains about 0·22 p.c. of oxides of cerium, lanthanum, and didymium; and on that from Meymac (department of Corrèze), in which the proportion is much less.

The author then describes how he has artificially produced didymiferous scheelite and crystallised tungstate of didymium. For this purpose amorphous tungstate of lime, obtained by double decomposition, was fused with chloride of sodium, and a small quantity of tungstate of didymium was added, when crystals of Scheelite were obtained, perfectly transparent and spectroscopically identical with crystals from Traversella.

R.C.B.

On the Hemihedral Forms of Alums (M. G. UZIELLI, *ibid.*)—With reference to the previous observations of M. Lecoq de Boisbaudran, the author remarks that, in crystals of chrome alum, striæ occur on the planes perpendicular to the face $a' = (111)$ which lies on the bottom of the vessel, and also on faces symmetrically placed with regard to that face.

If an octahedron rest on one of its faces a', the six oblique faces are inclined to that face; the striæ then appear only on the three faces visible in the perpendicular projection of the crystal on the plane of the face a'. As these three faces belong to a tetrahedron derived from the cube, and the striæ are normals to the edges of the face a', *i.e.* they are in planes perpendicular to the faces of the rhomboidal dodecahedron; the fact can be explained by the ordinary laws of hemimorphism.

At the conclusion of this paper, some remarks are made by M. Lecoq de Boisbaudran, in which he states that he found no striæ in the crystals prepared by himself, but there were four rugose, dotted faces, and four smooth ones. M. Uzielli's striæ have no connection with the internal structure, and they have always a fixed orientation with respect to the lower face of the crystal; so that they are simply furrows cut by currents produced in the liquid by change of density. They follow the direction of gravity, and similar furrows occur also in the erosion of other substances.

R. C. B.

On the Optical Properties of Isomorphous Mixtures (M. G. WYROUBOFF, *ibid.*)—The researches of De Senarmont and Des Cloiseaux have shown that optical isomorphism is quite different from geometrical. The phenomena of isomorphism may be considered under three heads,—geometrical, chemical, and optical,—independent in so far that an identity in each can exist without entailing an identity in the others. Thus regarded, isomorphism ceases to be a general law which must be continually supported with new hypotheses, and becomes a series of special laws.

The author divides those substances which can crystallise together, and produce isomorphous compounds, into three groups:—those which are chemically, geometrically, and optically identical; next those agreeing only in composition and form, and lastly those which are similar in composition, but differ in form and optical deportment. Red light was always employed by the author, in order to eliminate dispersion, and in cases where there was not sufficient transparency, the measurements were made in oil.

Group 1.—Optical properties are numerous and complex: they include the index of refraction (and consequently the angle of the axes in biaxial

bodies), the properties of double refraction and dispersion, and the orientation of the plane of the axes. All these points assist in the determination of species, but, for the present purpose, the first-named has a constant value. The index of refraction and the angle of the axis vary under conditions which are far from being understood—not that they are to be excluded from the conception of optical isomorphism, but they are secondary, the position of the plane of the axes remaining characteristic, and it is to this that attention will be confined. Two substances are selected because they form perfect crystals, and belong to the same series as the very curious double sulphate of soda and potash. The optical axes of the sulphate and the chromate of potash have the same orientation, parallel to $h' = (010)$: there is a difference only in the position of the acute bisector, and in the sign of the double refraction, which in the case of the sulphate is positive, and perpendicular to $p = (001)$, while in the chromate it is negative and perpendicular to $g' = (100)$.

When the two salts crystallise together, 6 p.c. of chromate suffices to alter the optic axes of the sulphate, the obtuse axes of which gradually approach, and when the proportion of chromate reaches 44 p.c., the axes of the pure chromate are obtained. At this point the salt is geometrically still the sulphate; the crystals are mostly combinations of m, e', g', with this last face much developed. With a slight addition, however, the form changes; the face g' disappears, and the faces $e' = (101)$ prevail; the crystals also lose their transparency, and do not regain it till the quantity of sulphate has decreased to 3, or even 2 per cent.

Group 2.—In this case a mixture of the sulphates of potash and ammonia is employed, their form being exactly the same, but the optic axes are differently oriented—parallel to $h' = (010)$, with the positive acute bisector parallel to $p = (001)$, in the former; parallel to $g' = (100)$, with the positive acute bisector perpendicular to h', in the latter. 2 p.c. of sulphate of ammonia suffices to bring the obtuse axes of the sulphate of potash nearer, this effect proceeding regularly at the rate of 4° 40′ for each per cent. of ammonic sulphate, or by 1° 10′ for each thousandth of ammonia. On reaching 18 p. c. (= 7 p.c. of NH_4), they cross, and give an almost uniaxal salt. Their plane then becomes parallel to p, and they diverge more and more, proceeding this time more rapidly, at the rate of 6° 30′ for each percentage of sulphate of ammonia. They thus come to form a right angle with about 30 p.c. of sulphate, presenting probably an obtuse bisector, the acute bisector being perpendicular to h'. To attain the optical properties of pure sulphate of ammonia, the axes must again cross, and then diverge in a plane parallel to g'. But the last phases of the transformation are difficult to follow, for when the quantity of sul-

phate of ammonia exceeds 30 p.c., the crystals become small and indi
tinct, and form complex macles.

Group 3.—To this group belong the mixtures of the sulphates
potash and soda, and of the chromates of the same bases. The tw
sulphates, chemically isomorphous, are not geometrically so, since th
sulphate of potash has (for the prism) an angle of 120° 24′, and that
soda an angle of 129° 20′; the orientation of the optical axes is al
different. The same remark applies to the two chromates, except
regards the optical deportment, for that of the chromate of soda is n
known. Nothwithstanding this dissimilarity, the two sulphates or th
chromates unite in indefinite proportions. It might be said—in acco
dance with a phenomenon of dimorphism—that sulphate of soda has tw
forms, one known, the other unknown, and resembling sulphate of pota
as happens with the nitrates of potash and soda. But this hypothesis
based on analogy, not on facts directly observed, dimorphism not hav
been hitherto observed in sulphate of soda. Moreover a series of fa
seem to contradict such a view, for in a mixture of two bodies, of wh
one is dimorphous, the one form being stable and the other unstable, it
found that one of these forms, generally the more stable, has a gre
morphogenic power. This happens with the sulphates of iron and
zinc, 20 per cent. of the former being sufficient to give the clinorhomb
form to the mixture. The sulphates of iron and of zinc, the sulphates
iron and of magnesia, the nitrates of potash and of soda, are all th
identical. Sulphate of iron which has 70 per cent. of sulphate of zinc
optically, pure sulphate of iron, not only by the position of the plane
its axes, but also by their angle, while sulphate of zinc with 10 per cen
of sulphate of iron is optically pure sulphate of zinc.

Such is not the case with the two sulphates of potash and soda. Inte
mediate forms exist, but, since rhombohedral crystals have very near
the same angles as rhombic crystals, there is very little geometric
difference. The double sulphate is however very difficult to stud
optically; well formed crystals are easily obtained, but they are eith
too small to be cut into slices, or else are composed of a number various
aggregated. On the other hand fine crystals of the double chromate a
readily formed.

R. C. B.

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*Contributions to the Study of Chemical, Geometrical, and Optical Is
morphism.* (M. G. WYROUBOFF, *ibid.* No. 6)—A continuation of the essay c
this subject in the April number. The definition of isomorphism arrive
at is that bodies are isomorphous when they have similar forms and uni
in proportions which are not those of their atomic weights. The autho

has endeavoured to prepare mixtures of the chromates of potash and ammonia, by adding chloride of ammonium to potassic chromate, and also by neutralising bichromate of potash. But crystallisation proceeded with difficulty; with 11 to 13 per cent. of chromate of ammonia, the form of the crystals of chromate of potash did not change, but the optic axes diverged. With more ammonia, decided crystals are not obtained; with a still greater quantity—approaching the formula $CrO_4\,K\,(NH_4)$—the crystals are clear and have quite a different appearance, but they are so macled as to be optically useless. From these facts it would appear that the combination belongs to two bodies exhibiting different geometrical forms, like the sulphates of potash and soda; and this is the case, for the chromate of ammonia is geometrically isomorphous with the sulphate of soda, not with the sulphate of ammonia. The chromate of ammonia is easily obtained, in crystals large enough to be cut into plates, by adding excess of ammonia to a hot concentrated solution of the bichromate of ammonia, and then cooling slowly. It is an unstable salt, quickly losing a molecule of ammonia, and becoming a bichromate. The crystals are in long needles, usually terminated at one end only by an obtuse pyramid, and exhibit a form identical with that of the anhydrous sulphate of soda. The combination of the chromate and the sulphate of ammonia takes place with difficulty; small macles are obtained, as in the case of the mixture with chromate of potash. From the geometrical isomorphism of the chromate of ammonia with the sulphate of soda, a combination of the chromates of soda and ammonia was tried, when a double salt with two molecules of water was obtained. The angle of the prism exhibits a striking analogy with that of the anhydrous sulphate of soda, and therefore with that of ammonic chromate. The four salts, the two anhydrous and the two hydrous, are perfectly isomorphous.

R. C. B.

On the Artificial Production of Minerals by Heat. (M. M. Fouque and Michel-Levy, *ibid.*)—Experiments based on the consideration of eruptive volcanic matter, were made on the common silicates of volcanic rocks, by first melting the constituents of the silicate, and then lowering the temperature slightly below the fusing point. In this way the following were obtained: albite, oligoclase, labradorite, anorthite, nepheline, leucite, melanite, pleonast, magnetite, pyroxene, melilite. The Leucite exhibited roundish crystals resulting from the combination of the octahedron faces b' (112) with the dioctahedron a_3 (211) of the quadratic system; they had no action on polarised light. Attempts to produce orthose in a similar manner were unsuccessful. By operating with several grammes of material, the authors obtained the following associations, identical with

those ejected by volcanoes:—labradorite with pyroxene and magnetite, and these last two with leucite (leucitite); and nepheline with pleonast and melanite. Many inclusions of gas-bubbles were obtained, especially in the crystals of labradorite, leucite, anorthite, and nepheline, similar in appearance, composition, and form, to those found in eruptive rocks. Negative crystals were abundant; those of anorthite exhibited the faces p (001), g' (010), m (110), t (110), and giving in section regular hexagons or parallelograms.

Some silicates were very refractory: thus black mica, Wernerite, and amphibole could not be obtained. On fusing the constituents of black mica, two substances were obtained, the one orthorhombic, brown, and somewhat dichroic; the other formed very long colourless microliths, strongly birefractive. The constituents of Wernerite (dipyre. 1, 2, 6) mixed with a trace of fluoride of sodium and fused, produced fine crystals of labradorite. Wernerite and amphibole from Odegaard near Bamle (Norway), similarly treated, produced an association of labradorite and pyroxene. A mixture possessing the composition of oligoclase with an excess of one-tenth of alumina gave rise to an association of many crystals of oligoclase, with a few of labradorite.

R. C. B.

An Artificial Crystallised Quartz. (M. M. FRIEDEL and SARASIN, *ibid.*)—Crystals of quartz have already been obtained by de Senarmont, who heated gelatinous silica in hydrochloric acid; by Daubrée, by the action of superheated water on glass; and by Hautefeuille, by heating silica to about 800° with tungstate of soda. The method adopted by the authors is to heat, to a temperature below dull red, a mixture of potash, precipitated alumina, and an excess of gelatinous silica in presence of water. At the expiration of 14 hours in one experiment, and 38 hours in another, nearly the whole of the silica was crystallised. In the first case a number of very small regular crystals were obtained, exhibiting only the hexagonal prism e^2 (10$\bar{1}$0) terminated by the double pyramid $p\ e^{\frac{1}{2}}$=(10$\bar{1}$1), (01$\bar{1}$1), and acting strongly on polarised light; the second time the crystals were much larger, and accompanied by small crystals connected together in masses and diverging from a central mass whose exterior was covered with hexagonal pyramids. They show all the characters of natural crystals, such as the striæ parallel to the intersections of p and $e^{\frac{1}{2}}$ with e^2, and the unequal development of the faces p and $e^{\frac{1}{2}}$. In an experiment in which somewhat less silica was present, some crystals were of the deformed variety termed *sphalloid* by Haüy. A description of the apparatus employed is appended to the paper.

R. C. B.

On Mallardite. (M. A. Carnot, *ibid.*)—In the Ecole des Mines are several minerals from Utah, and in one specimen were many fragments of an undescribed species,—a hydrated sulphate of manganese, analogous to that obtained in the laboratory by crystallisation at a low temperature. They were fibrous in structure; hyaline, and colourless, readily soluble in water, and very efflorescent. On heating, much water was given off, and then fumes of sulphuric acid, leaving a reddish-brown residue. Fused with carbonate of soda and nitre, a green mass was obtained, exhibiting the characters of a manganate. An aqueous solution of the mineral gives with basic salts the reaction of a sulphate; with sulphhydrate of ammonia a precipitate is thrown down, rosy, or grey to blackish, according to the greater or less absence of sulphate of iron. The results of two analyses are as follows:—

	I	II	Oxygen.	
Sulphuric acid	26·0	29·0	17·40	$=5\cdot80\times3$
Protoxide of manganese ..	20·9	23·6	5·31	
Do. iron	0·3	—	—	
Magnesia	1·2	0·6	0·24	$=5\cdot75\times1$
Lime	0·8	0·7	0·20	
Water	36·8	44·5	39·55	$=5.65\times7$
Insoluble residue	14·0	1·6		
	100·0	100·0		

The first was made by M. Rioult, of the Bureau d'essai, the second by the author on a carefully cleaned specimen. Formula $=Mn\,SO_4+7\,H_2O$.

Some minerals are known to contain sulphate of manganese, especially Apjohnite and Dietrichite, which are double sulphates of alumina and manganese, Fauserite (double sulphate of manganese and magnesia), and Szmikite, a sulphate of manganese with one equivalent of water. The mineral in question is a distinct and well-defined species, and the name Mallardite is proposed for it, after M. Mallard, the president of the French Mineralogical Society, by whom it is added that the mineral appears in the form of very transparent parallel fibres; those which could be isolated exhibit the prism m (110) with four faces modified by the faces g' (010); its crystallisation being probably oblique.

R. C. B.

An Artificial Dioxide of Manganese. (M. A. Gorgen, *ibid.* No. 5, May, 1879.)—On heating crystallised nitrate of manganese, it first melts, and then boils; decomposes at about 135°, and gives off nitrous fumes, leaving the pure dioxide. To obtain it in crystals the author decomposes the salt very slowly at a temperature of 155° to 162°, for 24 hours, in an oil or

paraffin bath. The binoxide thus produced has the same properties as polianite, as to density, hardness, colour and crystallisation.

R. C. B.

On the Production of Caystallized Chromates. (M. L. BOURGEOIS, *ibid.*)—By a procedure similar to that adopted in his preparation of chromate of barium, the author has obtained the chromates of strontian and lime. The former presented fine yellow rhomboidal plates, with an angle of 101° 40′; cleavage parallel to the prism $m=(110)$; decomposed by continued red heat and somewhat soluble in water. The chromate of lime formed fine yellow needles of a brilliant silky lustre, apparently right angled. Slightly soluble in water, and more easily decomposed by heat than the preceding. By operating on equal portions of barium and strontium, or of barium and lime, the author has obtained double chromates in long prisms; with strontium and lime large tabular crystals were obtained, like those of the chromate of strontium. Hence the chromates of the alkaline earths are isomorphous one with another, and also with the corresponding sulphates, both as to form and composition.

R. C. B.

New Researches on Hopeite. (M. DAMOUR, *ibid.*)—This mineral, named after the Scotch chemist, Hope, was first described by Brewster, in the *Trans. Roy. Soc., Edin.*, 1824, but owing to its rarity, it has not hitherto been thoroughly analysed. The author, having had 2 mgrms. of it placed at his disposal, found that it is soluble in nitric acid without effervescence. On evaporating to dryness, it entirely dissolved in weak nitric acid. The liquid was then divided into two portions; the first, treated with ammonic molybdate, gave the greenish-yellow precipitate characteristic of phosphoric acid. Excess of ammonia, added to the second part of the solution, produced no precipitate, but ammonic hydrosulphide threw down sulphide of zinc of a blackish colour, owing to presence of iron. A long series of angular measurements is annexed.

R. C. B.

On the probable Identity of Microcline and Orthose. (M. A. MICHEL-LEVY, *ibid.*)—The association of these two minerals is remarkably intimate; they have the same chemical composition, and their crystals are very nearly alike. It has also been observed that the extinction produced by microcline between two crossed Nicols, in parallel rays, agrees with that of orthose. A demonstration, accompanied with a diagram, here follows, whence the author concludes that as all the other felspars extinguish the light in circumstances differing from those described, this agreement can hardly be regarded as accidental.

R. C. B.

On the Optical Properties of Isomorphous Mixtures. (M. H. Dufet, *ibid.*)—The author states that in mixtures of isomorphous salts, the differences between the principal indices of the mixture and those of the component salts are in the inverse ratio of the number of equivalents of the two salts forming the mixture. If the equivalent of the compound salt be calculated, a straight line is formed by taking the equivalents for abscissæ and the indices for ordinates. By taking lengths proportional to the corresponding indices of the two salts on the lines perpendicular to the axis of x, and then joining the points representing the corresponding indices, straight lines are obtained which do not intersect; the plane of the axes does not alter, a condition which obtains in the mixture of the sulphates of zinc and magnesia studied by the author, and in the mixture of the chromate and sulphate of potash studed by M. Wyrouboff. Two of the lines can intersect, and then a uniaxal salt is obtained with a given composition, as is the case in the potash and ammonia salts of Seignette. One of the lines can intersect the two others, as happens in the mixture of the sulphates of potash and ammonia, and there are then two uniaxal salts.

R. C. B.

On some Crystallised Tungstates. (M. L. Michel, *ibid.*)—To obtain these the method of Geuther, Schultze, Forsberg, etc., was adopted, which consists of melting at a high temperature an alkaline tungstate (e.g. sodic tungstate), with a mixture of sodium and metallic chlorides. The fusion is conducted in a porcelain, contained in a Hessian crucible, the space between being packed with calcined magnesia. The mass is slowly cooled and then treated with water to extract the soluble chlorides. Crystals 1 cm. long and 1½ mm. wide were thus obtained. The proportions employed were:—1 part of tungstate of soda, 1½ of the metallic chloride, and two parts of sodium chloride,—the excess of this last giving larger and more regular crystals. By this procedure the author has obtained the tungstates of barium, strontium, calcium (Scheelite), magnesium, manganese (Hubnerite), iron, iron and manganese (Wolfram), cobalt, nickel, zinc, cadmium, copper, and lead (Stolzite); also the tungstate of bismuth (not hitherto obtained), in greenish-white nacreous plates.

R. C. B.

Boracite. (*Ibid.* No. 6, June.)—In an abstract from a late number of the *Zeitschrift für Krystallographie* (Vol. III, No. 4), it is stated that M. Baumhauer has studied the crystallisation of this substance, as developed by corrosion-figures, whence he has deduced that it is orthorhombic, and that the cubic form is due to an assemblage of six orthorhombic crystals, constituting as many pyramids, and having the cubic faces as their bases.

R. C. B.

Minerals occurring at Sarrabus (*Sardinia*), *ibid.*—In a communicatio from M. Traverso, it is stated that veins of silver and lead ores are bein worked at this place; they occur in granitoid porphyries, amphibole quartzite, with pyrrhotine, and black schists with pyrite and calcareou veins. The gangue consists of calcite, fluor, baryte, quartz, and steatit Associated minerals are: native silver, argentite, *argent fragile* or psatu rose, red silver (argyrithrose), galena, blende, copper pyrites, grey copp (tetrahedrite), molybdate of lead (wulfenite), carbonate of lead, Breithau tite, harmotome, gypsum, dolomite, and Aragonite.

R. C. B.

On Breislakite. (The same, *ibid.*)—This was observed as brownis filaments on a druse of tridymite, amongst crystals of hypersthene, fr the sanidine-trachyte of the Roc du Capucin, Mont Dore. They had appearance identical with those of the trachyte of Monte Olibano.

R.C.B.

On the Composition of Hopeite. (M. M. FRIEDEL and SARASIN, *ibi* —The authors have succeeded in producing a substance with the cryst line and optical properties of this mineral. Oxide of zinc was mixed various proportions with a dilute solution of phosphoric acid, and t whole heated in closed tubes at from 150° to 180° for about 16 hou The contents became crystalline, and under the microscope exhibite crystals apparently orthorhombic, together with others in triangul plates. As these last became more numerous with a greater amount phosphoric acid, it was increased till its weight equalled that of the oxi of zinc, when the product became free from orthorhombic prisms. Tab lar crystals were thus obtained, rectangular or six-sided, and symmetric the smaller sides of the rectangle disappearing through the replacem of the angles with obtuse slopes. These sloping sides contain an angle about 150°; the angle of the faces a^3 a^3 of Hopeite is 149° 16′ (Levy Measured with the goniometer, it was found that the angle of the fac $m\,m = 120°$, $m\,g' = 120°$; those of Hopeite are 120° 26′ and 119° 47 The optical properties are also similar. In parallel polarised light, t planes of extinction are parallel to the sides of the rectangles. Wi converging light, there is a disposition of symmetrical colours, and wi plates sufficiently thick, there is an appearance of the neutral lines ind cating that the plane of the axes is parallel to the base of the prism. C analysis, these artificial crystals gave:—

Phosphoric acid	31·12	31·07
Oxide of zinc..	53·52	53·18 } Theory.
Water	14·45	15·75
	99.09	

Formula = P_2O_5, 3Zn O, 4 H_2O. Only two molecules of water are given off at 100°. Hopeite is therefore very probably a tribasic phosphate of zinc.

R. C. R.

On Artificial Libethenite. (The same, *ibid*.)—It has been shown by Debray that this substance is obtained, as a crystalline powder, when the tribasic phosphate of copper, P_2O_5, 3 CuO, 3 H_2O, is heated with water in sealed tubes. The boiling temperature is sufficient to change the tribasic phosphate into greenish-white crystalline Libethenite. To obtain fine crystals, it is necessary to employ a closed vessel at about 180°, with an excess of phosphoric acid. Olive-green crystals were thus obtained, exhibiting the faces *m* and *a'*; the angles found were, *m m* = 87° 30', *a' a'* = 70°—71°; in Libethenite, *m m* = 87° 40', *a' a'* = 70° 8'. When either the natural or the artificial mineral is reduced to powder, and ignited at a red heat in a test-tube, or on platinum in the Bunsen flame, water is given off, and a substance results which is brown while hot, and of a fine green when cold.

Olivenite, which much resembles Libethenite, gives merely a brown powder on calcination.

R. C. B.

On the Preparation of a Felspar. (The same, *ibid.*)—By using the apparatus employed in their production of artificial quartz, and a mixture composed of the silicates of alumina and potash, together with a small quantity of caustic potash, the authors obtained a crystalline powder after heating the mixture to a dull red for 36 hours. This powder behaves under the blowpipe like felspar, and fuses with difficulty to a white glass. Its density is the same as that of orthose. Analysis showed that a felspathic matter was obtained, viz.:—

		ORTHOSE	POTASSIC PETALITE.
Silica	72·0	64·63	70·90
Alumina	14·9	18·49 calculated	15·21
Potash	12·2	16·87	13·83

The result agrees with a mixture of orthose and quartz, or a felspar rich in silica, analogous to petalite, and mixed with a small quantity of quartz.

R. C. B.

Epistilbite. (M. des Cloiseaux, *ibid.*)—From an examination, with the micro-polariscope, of more than two dozen cleavage-plates of specimens from Berufjord and Ofjord, the author finds that there exists in them a

twin-plane tangent to the obtuse edge $\frac{m}{m}$. He concludes that it should be considered as belonging to the clinorhombic system, and remarks on the necessity of new and exact measurements.

R. C. B.

On a Chromiferous Garnet from the Pyrenees. (M. A DAMOUR, *ibid.*)—This mineral forms an essential part of a crystalline rock of a pale-green colour, containing calcite, quartz, and a white mineral, very fusible under the blowpipe, and exhibiting a relation to Wernerite or Zoizite. By acting on this rock with dilute nitric acid, the calcareous part is dissolved and small druses are set free, in which the green garnet appears crystallised as rhomboidal dodecahedra. This mineral, being variously fissured, is easily broken, retaining the hardness of the garnets = 6 to 7; spec. grav. = 3·43. Melts with difficulty before the blowpipe to a black glass, not magnetic; with borax or microcosmic salt it gives an emerald-green glass. The analysis was as follows:—

			OXYGEN	RATIO.
Silica	36·20		19·30	2
Alumina..	10·20	4·75		
Chromic oxide	6·50	2·04	9·67	1
Ferric ,, ...	9·60	2·88		
Ferrous ,, ...	8·16	1·81		
Manganous oxide	0·50	0·13	9·79	1
Lime	27·50	7·85		
	98·66			

whence the formula = 3 (CaO, FeO, MnO) + (Al_2O_3, Fe_2O_3, Cr_2O_3) + 3 SiO_2. This analysis agrees with that of a chromiferous garnet from Orford (Canada), as found by Mr. Sterry Hunt. There is not enough oxide of chromium to connect it with Uwarowite, but it seems rather to be a variety between Uwarowite, almandine, and melanite. The mineral described was found near Venasque, on the Pic Posets, near Maladetta.

R. C. B.

On Venasquite. (By the same, *ibid.*)—This mineral, so called from being found near Venasque, was first described by M. N. Boubée in 1857, and referred by him to Ottrellite. It occurs in crystalline masses, lamellar and radiated; in colour it is greyish-black, powder grey. H = 5·5. G = 3·26. Heated in a tube, a little water is given off. Under the blowpipe, the thin edges melt with difficulty on platinum; on charcoal, a black scoria is formed, slightly magnetic; microcosmic salt gives the reaction of

iron, with a silica skeleton. Not attacked by acids. Analysis gave the following result:—

			OXYGEN.	RATIO.
Silica	44·72		23·89	6
Alumina..	29·71		13·84	3
Ferrous oxide.. ..	20·75	4·61	4·85	1
Magnesia	0·62	0·24		
Water	4·93		4·38	1
	100·80			

giving a formula=(FeO, MgO) Al_2O_3, 3 SiO_2+H_2O; while that of Ottrelite from Luxemburg is=3 (FeO, MnO) 2 Al_2O_3 6 SiO_2+3 H_2O, the manganese being sufficient to form a distinctive character.

R. C. B.

On Luckite. (M. A. Carnot, *ibid.*)—In some specimens of the Mallardite from the "Lucky-Boy" silver mine, Utah, occur many crystals of hydrated sulphate of iron containing manganese; they are clear and of a bluish tinge, and form furrowed prisms, irregular and somewhat twisted. Both in the dry and wet way, they give all the reactions of hydrated sulphate of iron, or melanterite, but manganese is also present. The result of analysis was:—

		OXYGEN.	
Sulphuric acid	26·3	15·78	=5·26×3
Ferrous oxide	21·7	4·80	=5·45×1
Manganous oxide ..	1·9	0·43	
Magnesia	0·2	0·08	
Lime	0·5	0·14	
Insoluble residue.. ..	7·2		
Water (by diff.)	42·2	37·55	=5·36×7
	100·0		

when the formula is SO_3, FeO, MnO+7 H_2O, in which the proportion of manganese is about one-tenth that of iron. The mineral would seem to occupy a position between melanterite and Mallardite; but on exposure to the air it does not effloresce, like the latter, nor exhibit an ochreous colour like the former. It constitutes a manganiferous variety of melanterite, and the name Luckite, from the place of its occurrence, is proposed for it.

R. C. B.

Szaboite. (A. von Lasaulx and A. Koch, *Zeit. für Kryst. und Min. VII*, 3, pp. 288 and 307.)—This mineral is known to occur in four localities: Aranyer Berg, Transylvania (Koch); Monte Calvario at the

foot of Etna (von Lasaulx); in a trachyte of the Riveau Grand, Mont Dore (Gonnard); and lastly on lava at Monte Corvo, near Biancavilla. The specimens from the last two places are chocolate-brown; those from Mont Dore (Puy de Dome) have the yellow colour of certain sphenes, while those from Monte Corvo are of a greyish colour.

The crystals hitherto met with are figured in Pl. XIII, figs. 3 to 5. See also *Min. Mag.*, Vol. II, p. 248.

R. C. B.

Correspondence.

Montreux, March 6th, 1880.

To the Editor of the Mineralogical Magazine.

Sir,—I propound the following as a problem, as specially suitable for the attention of Cornishmen, since they live near the sea, and can no doubt obtain the use of suitable instruments.

Measure the angles of crystals, fixed on the axis of the moveable limb of

I.—A Bordas circle.

II.—A Theodolite.

Very truly yours,

MARSHALL HALL.

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Page 162, line 6 from top, for "it" *read* "to."
,, 162, ,, 9 ,, foot, for "was" *read* "were."
,, 172, ,, 22 ,, top, for "flat, beach-covered, for" *read* "flat beach, covered for."
,, 177, ,, 4 ,, foot, for "SHAPINTHAY" *read* "SHAPINSHAY."
,, 210, ,, 21 ,, top, for "pyrargyrite" *read* "pyrargillite."
,, 177, ,, 10 ,, ,, for "aca" *read* "arca."
Same line for "water-worm" *read* "water-worn."

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